AGRICULTURAL ENGINEERING

OCTOBER • 1953

In this Issue . . .

ASAE Winter Meeting • Chicago, Ill., December 7 to 9

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AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS FOR OCTOBER, 1953

Vol. 34, No. 10

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There's no substitute for "total engineering" in screw conveyors

LINK-BELT integrates all components to give you the right screw conveyor for your machines

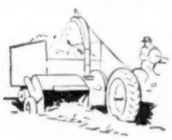
Here's how "total engineering" works for you when you buy Link-Belt Screw Conveyors. First, Link-Belt conveyor specialists analyze your needs—then recommend the right components. That means you get the exact type and size for your particular requirements . . . engineered to suit *your* needs.

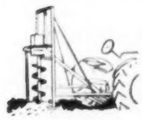
In addition, Link-Belt Screw Conveyors are accurately made for easy assembly and smooth, long-life operation. They help to make your farm machinery designing task easier, more flexible.

Ask the Link-Belt office near you for any engineering assistance you need.

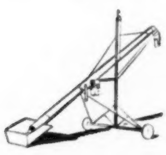
Link-Belt builds augers and screw conveyors for farm machinery of all types

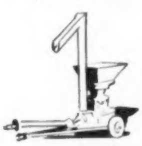

Combines

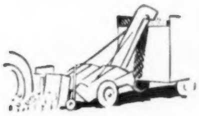

Forage harvesters


Post hole diggers

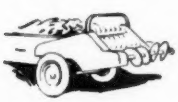

Hay balers


Grain loaders


Feed grinders


Cotton harvesters


Forage blowers

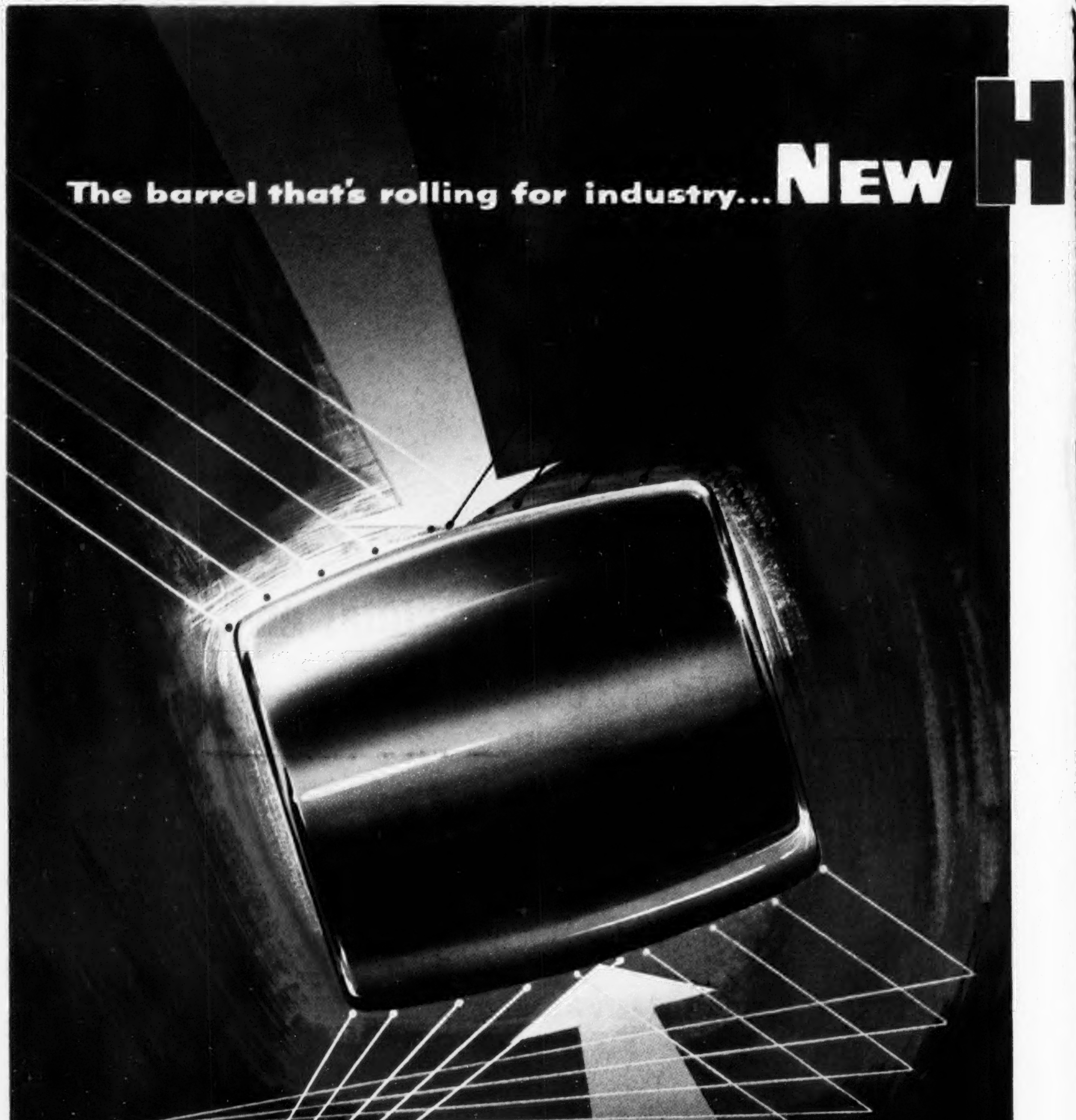

Manure spreaders

LINK-BELT

SCREW CONVEYORS

13,143-C

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in Principal Cities. Export Office, New York 7; Canada, Scarboro, Ont.; Australia, Sydney; South Africa, Springs. Representatives Throughout the World.



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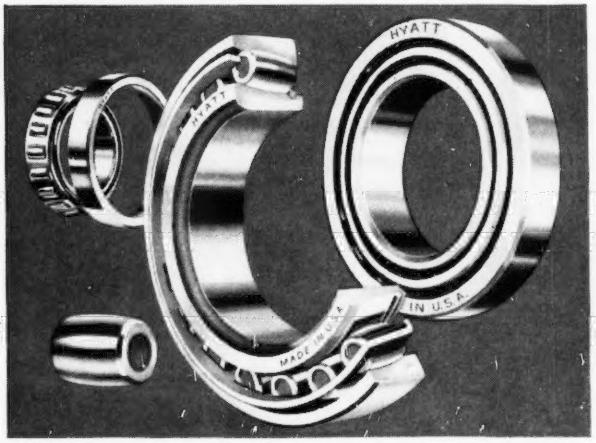
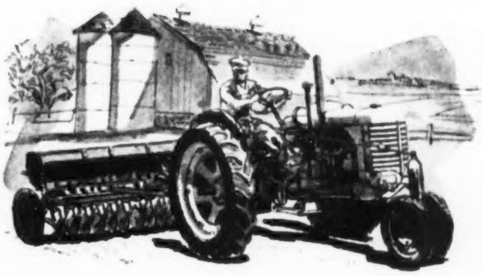
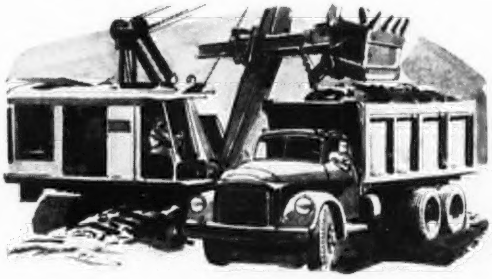
The Barrel name comes from the barrel shape of the rollers . . . but its superiority in bearing applications comes from *dual-purpose design* and *self-aligning ability!* This unique bearing takes load from any direction . . . and operates at full load-carrying capacity under conditions of misalignment! And in addition, the barrel shape of the rollers combines the low rolling friction of a ball with the high load capacity of a cylindrical roller—so that the Barrel Bearing is ideal for a wide range of applications.

Expensive? *Not at all!* Advanced manufacturing processes—plus the facilities of one of the newest and finest bearing plants in the world—make the initial cost far lower than you would expect! . . . For full information on this newest solution to the friction problem, write to the address below.

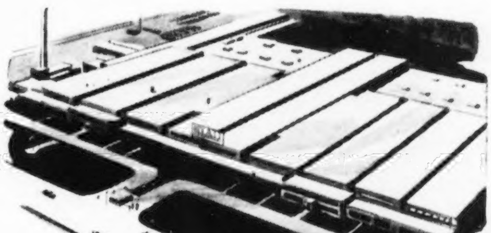




Self-aligning action makes the Barrel Bearing ideal for tractors and farm implements. Over many years, its durable, dependable performance has been established in a wide range of these applications.



In trucks and construction equipment, too, Hyatt's Barrel Bearing operates with full efficiency under conditions of heavy, multiple-direction loading. Unique roller and race design distributes the load over large areas of contact.



Hyatt's new plant, in Clark Township, N. J., is among the most modern in the world. New equipment makes possible advanced manufacturing processes and research facilities are the finest in the bearing industry.

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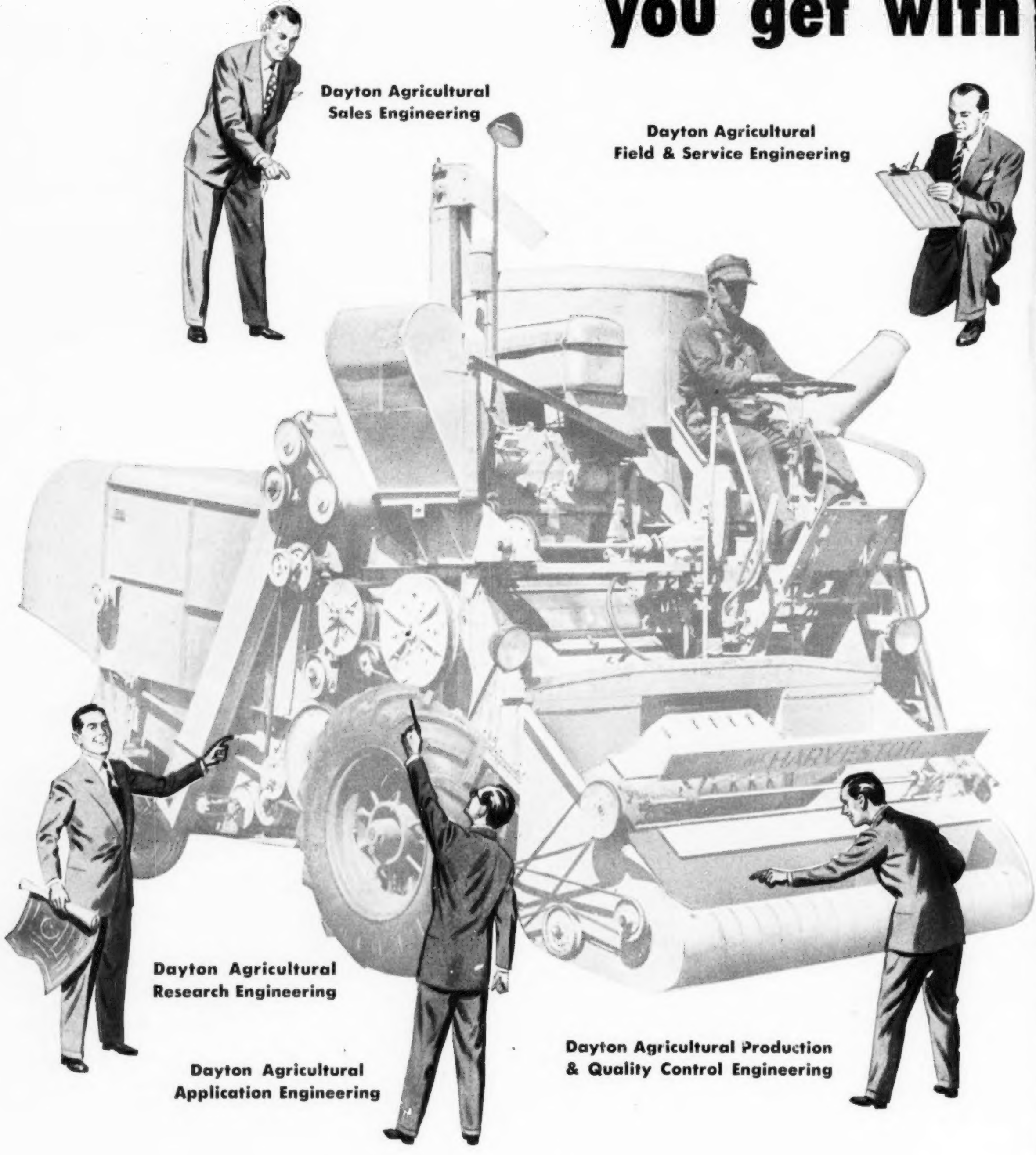

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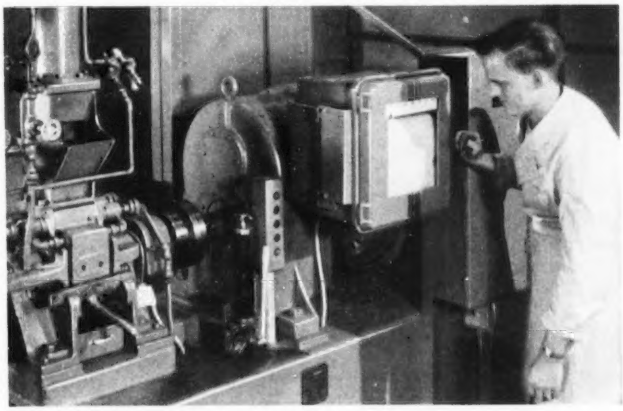
For agricultural belts and rolls aren't just a sideline to Dayton Rubber—our Agricultural Original Equipment Division is a complete organization devoted to developing better rubber products for tough farm use.

If you have any farm implement belt or roll problem, give us a call, and see for yourself. There's no obligation, of course. The Dayton Rubber Company, Agricultural Original Equipment Division, 1009 W. Washington Blvd., Chicago, Illinois.



Does your problem involve research? Then rely on Dayton, makers of the *first* successful V-Belt, and pioneers in rubber research and development since 1905. For example, Dayton developed the process which made it possible to make rubber adhere to steel, and has led the way in developing oil-resistant and anti-freeze rubber.

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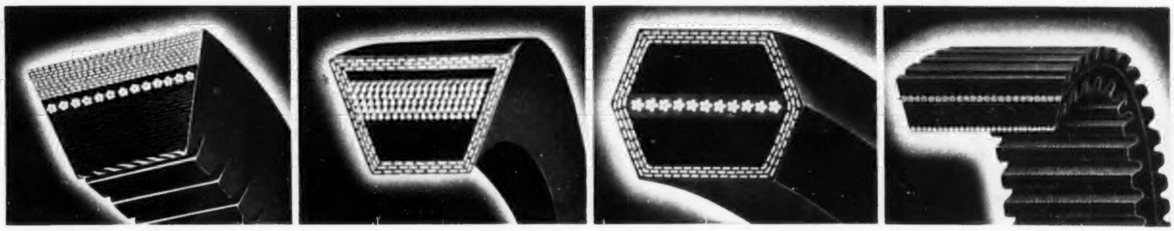
Dayton makes the right belt

FOR EVERY FARM IMPLEMENT!



Agricultural Cog-Belt*	Agricultural V-Belt	Agricultural Double Angle V-Belt	Agricultural Double-Cog Belt*

*T.M.

Dayton Rubber

Since 1905

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DAYTON RUBBER COMPANY, DAYTON 1, OHIO

WHAT'S YOUR UNIVERSAL JOINT PROBLEM ?

If you're building implements like these, BLOOD BROTHERS offers great advantages

PRODUCT	BLOOD BROTHERS Universal Joints now used by leading implement manufacturers: Series	
Combines	3DR	L16S
Corn Pickers	1FR	3DR
Corn Snappers	1FR	3DR
Cotton Pickers	L6N	L16S
Diskers & Seeders	1FR	
Dusters	L6N	1FR
Elevators	K-1-C	1FR
Ensilage Blowers	K-1-C	L6N
Feed Grinders	L14N	35N
Forage Harvesters	35N	
Grain Binders	K-1-C	1FR
Hammer Mills	L14N	35N
Hay Balers	3DR	L16S
Hay Rakes	L10S	1FR
	L6N	
Manure Spreaders	L10S	1FR
Mowers	L6N	L10S
	1FR	
Post Hole Diggers	K-1-C	1FR
Potato Diggers	1FR	3DR
Rotary Weeders	K-1-C	K2R
Shredders	L14N	35N
Shellers	1FR	3DR
Snow Plows	3DR	35N
	L14N	
Sprayers	35N	3DR
	1FR	
Swathers	1FR	3DR
Tractors	K-1-C	L6N
	L6S	
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	K2R	
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Need specific information? Blood Brothers will promptly supply details on these joints—or others suitable for construction equipment, trucks and buses, industrial machinery and marine applications. Our engineering staff—backed by 43 years' experience—will gladly assist you.

TORQUE CAPACITIES at Tractor Speeds of 550 rpm.

Series	Horsepower
K-1-C	3
K2R	3
L6S	4
L6N	5
L10S	5
1FR	10
L14S	11
3DR	15.7
L16S	19
L14N	30
35N	50

You can get joints alone or assembled with fixed or slip joint shafts... with or without integral safety shields, safety clutch, clamp yokes... or with the popular, salable quick-detachable yokes.


With Safety Clutch


1FR Series


PTO Slip Assembly


L6S Series


With Integral Safety Shields


Quick Detachable

BLOOD BROTHERS machine division

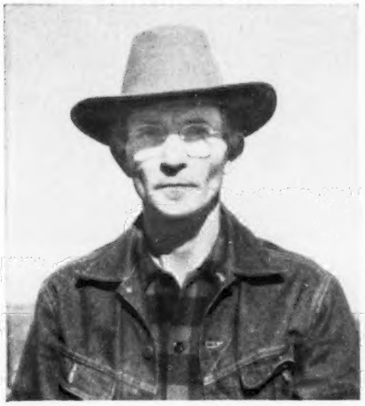
Rockwell Spring and Axle Company

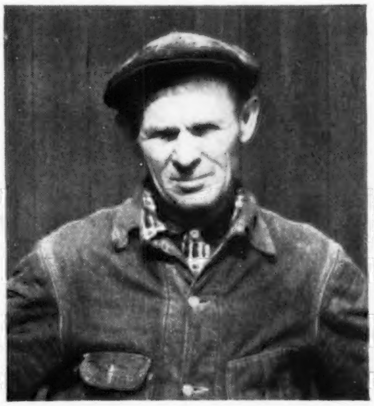
ALLEGAN, MICHIGAN

J. Wayne Armstrong, Ponca, Okla., says: "So far I have installed about 1280 pressure-creosoted fence posts on my farm, and any other I buy will be the same kind. Pressure-creosoted posts are fire-resistant, hold staples better, and have an average life of from 5 to 7 times as long as untreated posts."

Oscar B. Seifert, Mt. Vernon, Ind., says: "Two years ago I took down a fence which I no longer needed. The original wire was still on the fence, and the pressure-creosoted fence posts, after at least 37 years in the ground, were almost all in excellent shape when they were removed."

W. O. Moss, owner of Mile-Away Farms, Southern Pines, N. C., says: "I selected pressure-creosoted fence posts because they last 30 to 40 years—and require a minimum of repair work. I have about 80 acres under fence now, and plan to put in about 5000 acres as soon as possible."





These farmers know from experience

how pressure-creosoted fence posts save money

In thousands of installations in all parts of the country, farmers have found that pressure-creosoted fence posts last up to seven times as long as untreated wood posts. This means big savings in the cost of posts themselves over the years, plus big savings in labor required for frequent resetting.

On the basis of the experience of these thousands of farmers in many parts of the country, you can recommend pressure-creosoted fence posts as the most economical wood posts that can be used.

Many leading wood-treating plants use U·S·S Creosote—a product of United States Steel—in their pressure-treating operations. When fence posts are pressure-creosoted with U·S·S Creosote, you can be sure a quality product has been used.

If you would like information on approved methods of fence construction with pressure-creosoted wood posts, send for our guide "Fences That Pay." If, after examining it, you would like additional copies for educational programs, they will be supplied without charge. Use the coupon.

Agricultural Extension Section
United States Steel Corporation
Room 2815-N, 525 William Penn Place
Pittsburgh 30, Pa.

☐ Please send me your new guide, "Fences That Pay."

☐ Also, I would like to know the name of my nearest Pressure-Creosoted Fence Post Dealer. No obligation, of course.

Name ....

Address .... Town ....

County .... State ....

USS

UNITED STATES STEEL

"My Quonset works for me four ways..."

"It fills my needs for a **machinery storage** building, **workshop, garage** and surplus **grain storage**," says Endren P. Johnson. Mr. Johnson farms 240 acres near Huxley, Iowa, and specializes in growing hybrid seed corn.

There are many things he likes about his Quonset, but Mr. Johnson says, "The clear-span interior with those big doors and the all-steel non-combustible construction are what really convinced me." And he's glad he bought the inner-wall lining for 24 feet in one end—he stored 2000 bushels of soybeans for 90 days and made a profit of 23 cents a bushel on storage because he had a safe place to put them.

Mr. Johnson's machinery lasts longer, runs better and has higher trade-in value because it is sheltered the year around in his spacious Quonset. And he says his equipment is ready to go when he needs it due to better and easier maintenance in the shop which is located in one end of the Quonset.

Quonsets are available for any farm use—they are engineered to help you cut costs, save time and make profits. And they can be easily financed on the Quonset Purchase Plan. Your dealer will be glad to show you how.

Clear-span Quonset interior provides ample and efficient space for storage and handling of modern farm machinery for Endren P. Johnson, Huxley, Iowa.

Quonset drying and storing permits earlier, cleaner harvest, better market control for W. R. Mitchell, Grundy Center, Iowa.

Good looking, durable and easy to maintain. That's the Quonset all-purpose farm production tool.

Beef barn owned by A. W. Allely, of Montezuma, Iowa, is a time-saving, labor-saving Quonset 40x60.

Farm for the Future . . . with Quonset®

STRAN STEEL FRAMING

STRAN-STEEL REG. U. S. PAT. OFF.

GREAT LAKES STEEL CORP., Stran-Steel Div., Ecorse, Detroit 29, Mich.

Please send me the latest literature on Quonsets for farm service buildings and the name and address of my nearest Quonset dealer.

Name________________

Address________________

City or County________ State________

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GREAT LAKES STEEL CORPORATION

Stran-Steel Division — Ecorse, Detroit 29, Mich.

NATIONAL STEEL CORPORATION


B SERIES • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Bronze ball retainer . . . 38 sizes ½" to 3½" I.D.
C SERIES • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Pressed steel retainer . . . 16 sizes ½" to 1⁵⁄₁₆" I.D.
F SERIES • Light duty, one direction thrust bearing. Flat seat. Grooved races. Pressed steel retainer . . . 43 sizes ½" to 3½" I.D.
G SERIES • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 76 sizes ½" to 7⅜" I.D.
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1100 SERIES • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.
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R SERIES • Ball thrust retainer. One piece, pressed steel, channel type cage . . . 79 inch sizes 0.266" to 4.232" I.D.
Thrust Bearing Headquarters
Just Name Your Need
Whatever mechanized equipment you make or use—whether it is large, small, rugged, fragile, heavy or light—whether it must operate at high speed, low speed, under water, in acid or under extreme temperature or dust conditions, it will do its job better, more efficiently and more economically if bearing equipped. If it is equipment that lends itself to bearing applications of the thrust type—Aetna has the answer or can come up with it pronto. 37 years of thrust bearing know-how assures this. Inquiries invited. No obligation. Aetna Ball and Roller Bearing Company, 4600 Schubert Ave., Chicago 39, Illinois.
Aetna
Precision Bearings and Parts for Every Branch of Industry
CLUTCH BEARINGS • Ball thrust clutch release bearing. Banded. Pre-lubricated. T-type, oil impregnated bronze retainer assures concentricity and smooth, quiet, long-life performance.
SPECIAL BEARINGS • Facilities for sizes up to 38" O.D. Counsel that brings you the expert technical aid that has licked many of industry's toughest bearing application problems.
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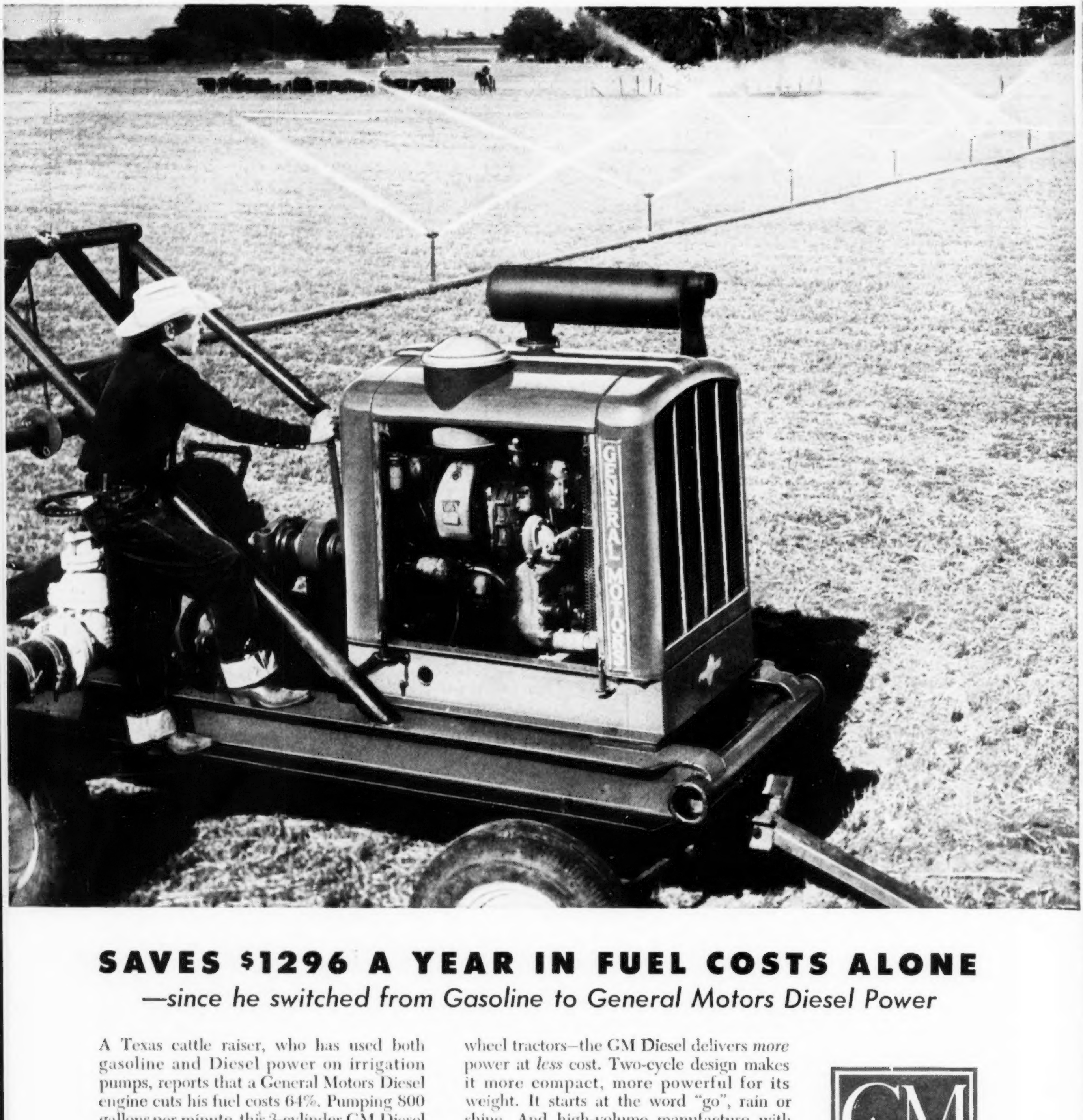
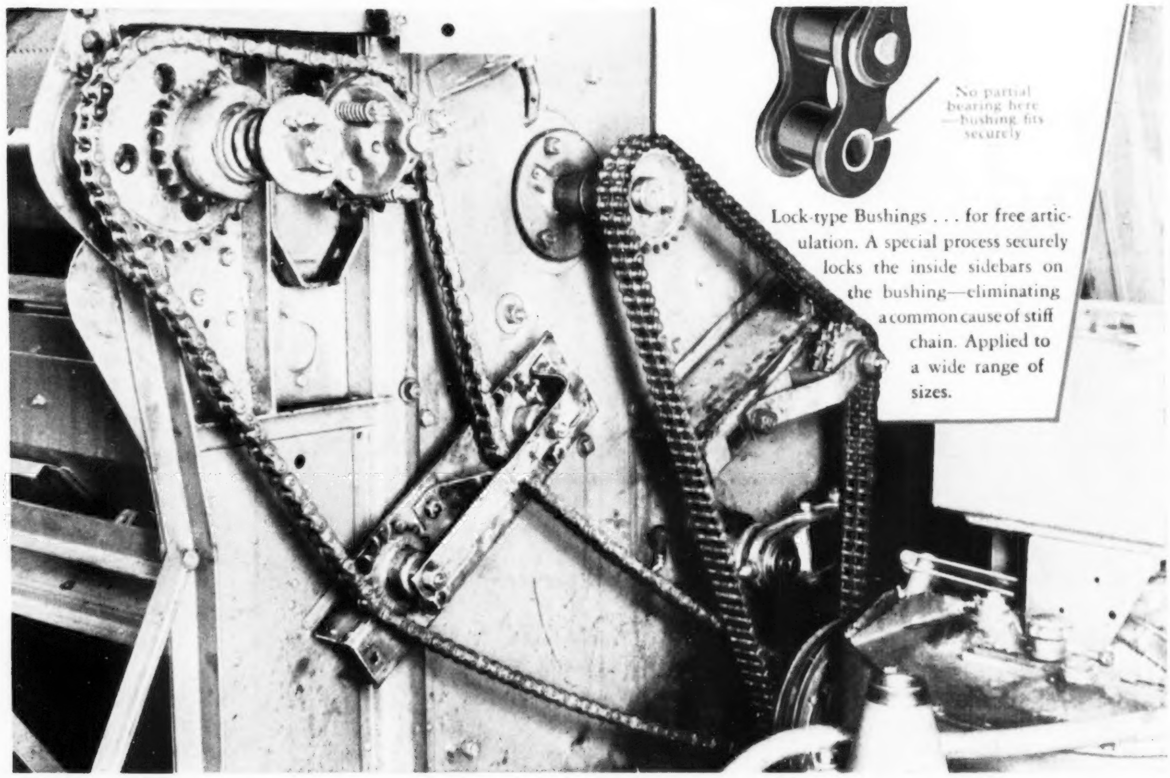

GENERAL MOTORS



Look to LOCK-TYPE BUSHINGS for longer roller chain life

Just one of many engineering extras you get from LINK-BELT

FOR drives that must operate under severe conditions, it will pay you to use Link-Belt Precision Steel Roller Chain. Lock-type bushings and the many other Link-Belt engineering extras add up to *built-in* extra life. Whether it's for power transmission or conveying, you are assured of a positive, flexible, economical chain . . . with high sustained efficiency. For complete information, see your nearby Link-Belt sales representative, or write for Engineering Data Book 2457.

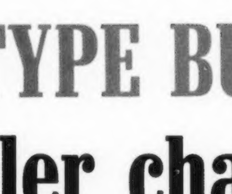
LINK-BELT

ROLLER CHAINS & SPROCKETS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia). Sales Offices in Principal Cities. 13,330

Don't overlook these other LINK-BELT extras


Shot-peened rollers have extra fatigue life under impact.



Couple and uncouple multiple-width chains more easily.

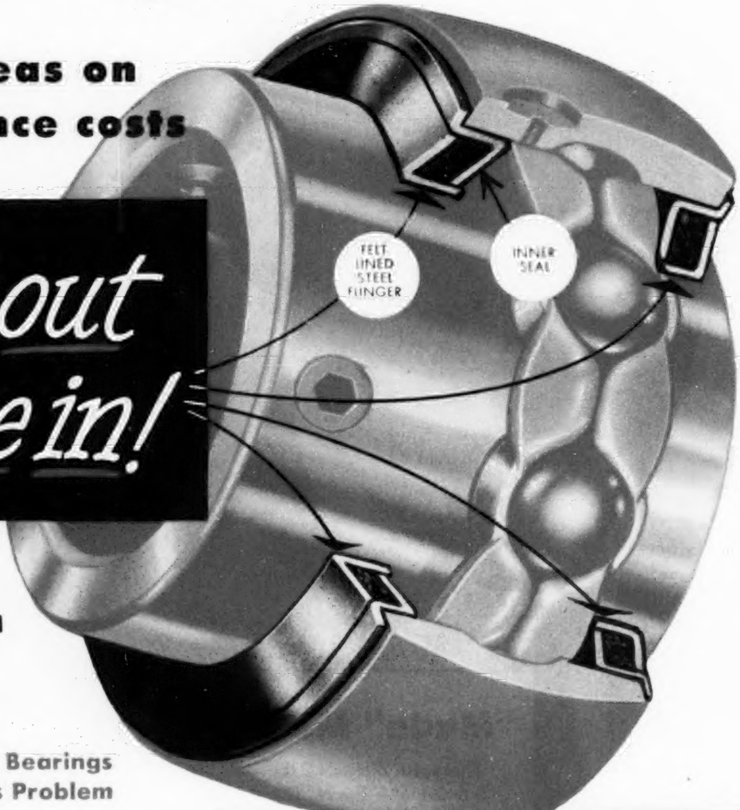
Closer heat treat control helps attain greater uniformity.


IT'S NEW!
Advanced Custom-Made Havoline would have been built even without the need which brought it sooner. For there is a creed of The Texas Company, one of those by which we live: Make Havoline "THE BEST MOTOR OIL YOUR MONEY CAN BUY" . . . and keep it best!
"Made" Motor Oil
This valve lifter took the same test but for 500 hours. It was lubricated with Advanced Custom-Made Havoline. Note the like-new condition, no wear. Keeping these valve lifters in your engine from wearing or sticking takes the best made motor oil. You can't get good performance from "slow poke" valves.
Advanced
CUSTOM-MADE
HAVOLINE
MOTOR OIL
TEXACO
THE TEXAS COMPANY

THIS SUPER Seal (EXCLUSIVE IN SEALMASTER BEARINGS)

obsoletes old ideas on bearing maintenance costs

IT KEEPS ***dirt out***
AND ***grease in!***



When dirt gets into bearings or grease leaks out, you've got trouble . . . high maintenance and replacement costs and all-too-frequent disassembly and downtime for machines.

Permanently Sealed SEALMASTER Bearings Were Developed to Lick This Problem

HERE'S WHY: In SEALMASTER Bearings, grooved, steel inner seals—permanently mounted on the outer race ring, one on each side, form the grease chamber.

Two annular felt-lined flingers rotating with the inner race ring and within the grooves of the inner seals, form the outer seals. The centrifugal action of these flingers effectively seals out all dirt. The bottom flanges of these rotating flingers, passing under and slightly beyond the inner seals, create a vortex action in the grease chamber. This breaks up the grease flow and retains just the right amount of grease to lubricate.

Whether your problem is dirt or simply making sure the bearings in the machines you make or use will give maximum service, SEALMASTER Bearings can help *you*. They are first class assurance of low maintenance costs and long bearing life! Write for Bulletin No. 845.

SEALMASTER

BALL BEARING UNITS

Cartridge Unit · **Flange-Cartridge Unit** · **Flange Unit** · **Take-Up Unit** · **Pillow-Block Unit**

SEALMASTER BEARINGS
18 Ridgeway Avenue, Aurora, Illinois
A DIVISION OF STEPHENS-ADAMSON MFG. COMPANY

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

Picture shows Dearborn Cotton Harvester with hydraulically dumped basket (sold separately). Can also be used with trailing wagon.

NEW DEARBORN COTTON HARVESTER

For hundreds of years human hands provided the only means of picking cotton. Within the last 15 years machines proved they could do it too.

But until recently, harvesting machines have been so complex that their price put them far beyond the reach of the majority of cotton growers. Thus, the average cotton farmer still had to rely on time-consuming hand labor. And to add to his plight, costs of labor have steadily increased while cotton prices have dropped. This combination often squeezes the grower's return to a "break even" point.

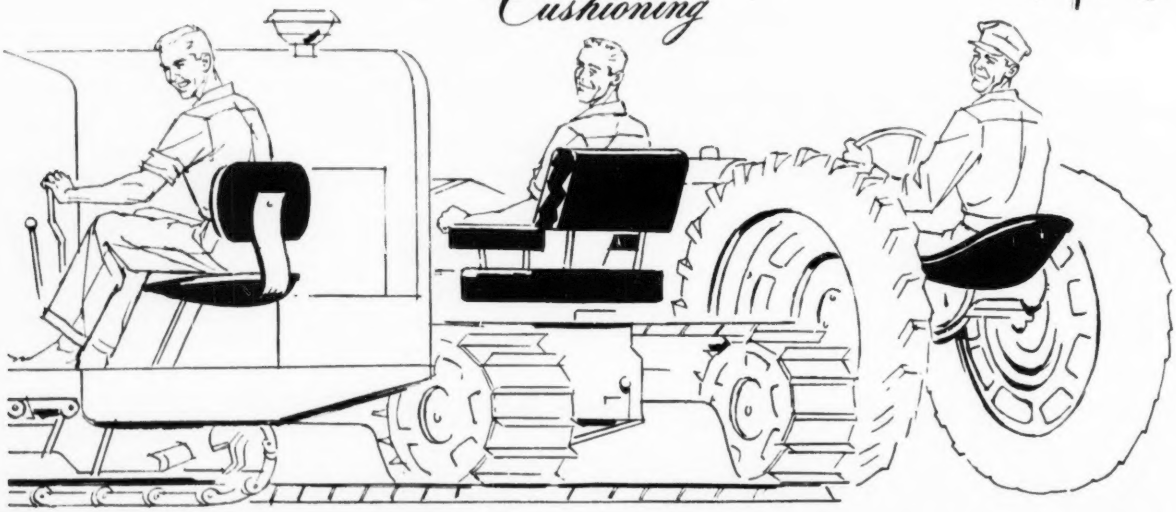
The new Dearborn Cotton Harvester, recently introduced, provides a solution to the dilemma. Throughout the cotton belt, farmer after farmer upon seeing this machine perform put in his order immediately.

This machine embodies a new principle of harvesting cotton with its unique "brush off" action. Thousands of flexible nylon bristles on revolving brushes remove cotton in a once-over operation. Actual tests show savings as high as $45 per bale and more! This extra profit is *clear* because the following items were deducted; depreciation, fuel, defoliation, and wages for the operator.

Here, at last, is the mechanical cotton harvester that is destined to create "White Harvest Magic" for thousands of farmers.

FORD TRACTOR DIVISION
FORD MOTOR COMPANY
2500 E. MAPLE ROAD • BIRMINGHAM, MICHIGAN

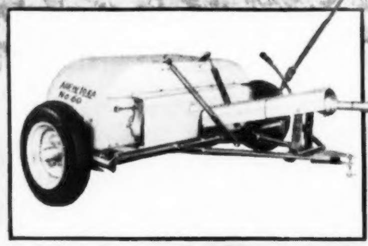
Ford Farming
MEANS LESS WORK... MORE INCOME PER ACRE



This Completely NEW NEW IDEA Stalk Shredder

A Safe Tool
PTO and drive are shielded

Well Balanced
. . . for easy hitching



...improves soil tilth
...makes valuable mulch

When you shred stalks, vines or weeds you make clean plowing possible, speed up the decaying process, put valuable organic matter back into the soil. Shredded crop residue helps prevent soil erosion. Any way you look at it . . . a NEW IDEA Stalk Shredder is a sound investment. It even requires less power to operate than most competitive stalk shredders! And, like all NEW IDEA implements, it is designed to save farmers both time and money.

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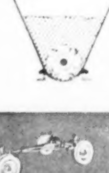

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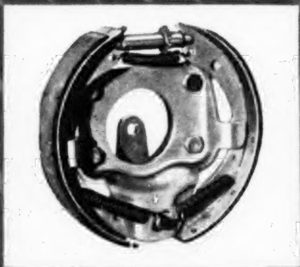

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AGRICULTURAL ENGINEERING

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What the Farm Equipment Industry Expects of the New Graduate Engineer

A. E. W. Johnson
MEMBER ASAE

MY SUBJECT is one of unusual importance to the farm equipment industry. It concerns one of our greatest assets – our employees – and particularly that group which is largely responsible for the technological advancement of our products and their manufacture, namely, our engineers. To some the newly graduated engineers, who are contemplating careers in industry, the choice of a life work is a perplexing experience during the transition period between graduation and finding your place in industry. Any uncertainty you may feel is undoubtedly due to an instinctive desire for advancement, security and personal satisfaction. Your choice to become engineers was doubtless based on your keen interest in science and technology and the confidence that this profession would offer you a career which would give you the greatest opportunity for accomplishment and personal satisfaction. If it is your earnest desire to contribute creatively to the advancement of your profession, and if the satisfaction of accomplishing something more than just earning a living continues to be your prime incentive, then satisfaction and recognition can be the by-products of your imagination and ingenuity.

Science, engineering and experience are the foundations of our industrial knowledge and progress. They are the basis of our nation's leadership as well as of our social and economic well-being. Engineering is indeed a profession worthy of highest esteem, and above all it offers unique opportunities for creative expression in the fields of research and invention.

Invention and the engineering of new products are the results of scientific research. Research and invention alone, however, can benefit no one unless the engineer takes their results and designs them into commercially useful products. Then after the product design has been completed, it must be manufactured on a sufficiently large scale and at an acceptable cost to purchasers so that wide distribution will result. This, of course, requires a large investment of funds and a financial risk for many people so that proper facilities for tooling and manufacture may be provided.

Research and engineering development, which is now an important part of every industry, have received great stimulus from the farm equipment industry. In the early days engineering tests and development work were conducted on farms. This is true even today. The laboratory tools of our experimental departments, as they were then known, were crude by comparison with the test facilities and laboratories we have today. Many of the early engineers lacked formal engineering education and training. However, their creative ability, ingenuity, skill and judgment in the commercialization of their ideas will always be an inspiration to those of us who were privileged to know these early designers and to witness the transitional period resulting in our present mechanized agriculture. Out of this era came the fundamentals on which our entire manufacturing industry is founded. Our steel mills, foundry facilities, techniques and practices, manufacturing processes and methods, and present assembly-line procedure are but a few industry practices, used even today, which had their early beginnings in the agricultural machinery business.

I have briefly mentioned the early development of our industry to emphasize the importance of technological advancements and to indicate the passing of still another era in agriculture with the beginning of a future in which the young engineers of today will play a most vital part.

Technological advancement of the last few years in agricultural developments, in manufacturing techniques and in engineering, will have significant and profound effects on the development of our

Today, more than ever, opportunities in the field of farm equipment design are unlimited. The great need for new and improved tractors and implements of all kinds has resulted in an increased demand for designers who have imagination and ingenuity and who can utilize these qualities in creative design

An address delivered to the agricultural engineering students attending the 46th annual meeting of the American Society of Agricultural Engineers at Pittsburgh, Pa., June, 1953.

The author—A. E. W. JOHNSON—is vice-president and director of engineering, International Harvester Co.

future products. As one example, we need only to review a few statistics to realize the probable future course of our agricultural economy. Since 1940 farm units have increased in size from 175 acres to over 215 acres per farm. Available farm labor has in turn decreased during this period from approximately 9,610,000 to 6,805,000 (U. S. Bureau of Census). Thus the demand in farm equipment will be for new tractors and machines with increased power, greater economy and improved efficiency, which will give the farmer more productive capacity per man with less physical effort. With the combined scientific research and development efforts of workers in government agencies, state experiment stations, agricultural colleges and industry, farming practices and production probably will achieve new goals. The use of farm products will increase as a result of better scientific farming practices, better seed and fertilizers, as well as improved and more efficient machinery. Thus over the years the people of our country will continue to have the highest standard of living, and the economic position of our farmers will continue to improve.

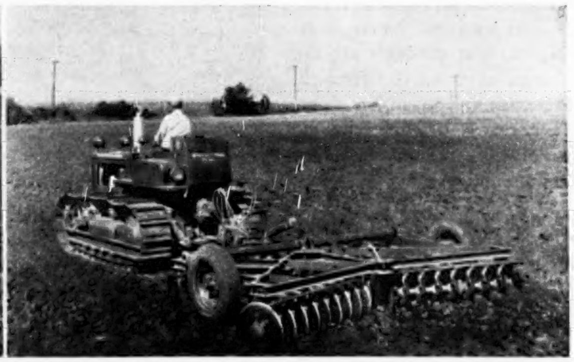
A more appropriate title for this address would perhaps be "How Can the Young Graduate Engineer Contribute Most Toward Industry and to the Agricultural Economy". It is unnecessary to point out that the success of our over-all economy, of individual companies, or of us as individuals, is dependent upon earnings or, as more commonly known, as profits. A company is expected to return to its shareholders not only dividends commensurate with their investment, but it is expected to put aside additional sums to be used as a reserve for securing the company's future and for providing expanded facilities and equipment which are necessary for future new products. Likewise the young engineer, in order to attain to positions of greater responsibility, is expected to contribute something more than that which normally might result from an average effort. It is only through the additional contributions of industry and its employees that profits and earnings can be achieved. These profits are necessary to secure jobs for all of us, to insure scientific and technological advancement, and to allow for the innumerable opportunities we as individuals generally take for granted in the free social economy in which we live.

Many of my statements specifically apply to the farm equipment business since that is the business with which I am most familiar. The farm equipment business, as a highly specialized industry, requires the services of many highly specialized engineering and technical people. In product engineering alone there are many requirements for engineers. Engineers are needed for crawler and wheel-type tractors, diesel and carbureted engines, combustion development, carburetion and fuel injection, transmission and chassis design, hydraulic controls, etc. In the farm implement field, engineering specialists are required for plows, seeding machines, planters, cultivating equipment, mowers and hay balers, to mention just a few of the many products which can be improved, to increase the productivity of agriculture and industry.

This should indicate to the young graduate that engineering specialization is the key to opportunities in his profession. This is the case whether or not he is engaged in government or industry research, engineering design or manufacture or merchandising services. In recent years the diversity of our company's products has greatly increased. In order to accommodate this greater diversification, we have established a divisional form of organization consisting of the farm implement, farm tractor, motor truck, industrial power and refrigeration divisions. This type of organization provides for many more opportunities of employment in the top operating levels of our company. Each of these divisions was formed with its own engineering department having paramount responsibility in the research, development, testing and improvement of the products it produced. Each engineering department is autonomous within its division and is under a manager of engineering who reports directly to the general manager of his division

In our company we realize the importance, to future advancement, of continued competition in our system of a free economy. In order to meet this competition it is fundamentally important that we have aggressive leadership in engineering so that the future economic position of our company as well as the customer may be advanced. In order to keep abreast of competition, our technical developments and the developments of others can only be adequately appraised by vigorous and progressive research and engineering development coupled with critical laboratory analysis and field tests. The only way this can be done effectively is to have an engineering organization which is equipped with proper research and engineering facilities.

Perhaps a brief description of our research and engineering organization will illustrate the importance which we attach to this phase of operation and give you an idea of the



These two views illustrate the application of hydraulic remote control to farm field equipment. *(Left)* International Harvester Farmall tractor plowing sod with four-bottom plow. *(Right)* International diesel crawler tractor and wheel-controlled tandem disk harrow

many opportunities which are available to young engineering graduates. Several years ago we purchased and equipped a complete plant which is devoted solely to manufacturing research. This organization has the responsibility of investigating and developing new methods of manufacture, assembly and packaging, as well as the investigation of new materials and their possible applications.

Each of our engineering departments includes an advanced engineering, a product engineering, and an engineering and test group. The advanced engineering group has the responsibility of developing machines for future manufacture, and the product engineering group is charged with the duty of improving the current products. In addition to the various divisional engineering departments we have also a research department at our Evansville, Ind., works and an engineering materials research and testing laboratory at our tractor works. We have an experimental farm at Hinsdale, Ill., where we experiment with new machines and try out new farming practices. At this farm we also have a farm tractor proving ground with service facilities where tractors are tested around the clock to accurately measure and evaluate tractor and component performance and life. Also we have recently dedicated a new engineering and research laboratory at Fort Wayne, Ind., for the purpose of serving our motor truck division. This laboratory is one of the most modern of its kind in the country. We have recently completed an entirely new engineering and laboratory facility at the Melrose Park works of our industrial power division. At Phoenix, Ariz., we have a test facility comprising 4,800 acres for testing engineering developments relating to motor trucks and heavy industrial and crawler tractors. The location of this facility permits us to have year-round operation. We have a farm practice research section which carefully follows the research developments of federal and state experiment stations so that we may be in a better position to apply the new information which is being constantly developed. In total we have approximately 1,200 technical engineering employes in our divisions who are engaged in some phase of research and engineering development.

I have briefly described our company's research and engineering operations to show that we are deeply conscious of the importance of engineering and to point out the many opportunities which exist in our company and in the farm equipment industry as a whole. We can fairly make the claim that our industry has openings for all kinds of engineers to do all kinds of work.

The graduate's first job in industry will be to gain experience. His first assignment, after an orientation period, may not be one of great responsibility regardless of his education and field of specialization. It must be remembered that success in business is based upon experience. The graduate's first task is to apply himself and to gain the confidence of the men he will have to work with. He must earn his right to move up to a higher level. Each new assignment will provide for him a new adventure and a new opportunity to prove himself competent and worthy of increased responsibility. We accept unhesitatingly the limitations of his academic training. We expect, however, that he has been well grounded in engineering fundamentals, that he has a trained mind, that he can think logically, that he has the ability to analyze and classify information, and that he can express himself clearly. We do not expect him to be an experienced engineer. Most important, however, we do expect young men with enthusiasm and with inquiring minds.

The young graduate engineer is expected to realize that he is not a finished engineer and that much practical experience must be added to his theoretical knowledge. College has given him the tools with which to work. He must now learn to apply these tools in the solution of practical engineering problems. Thus, as his experience grows, so do his concepts of engineering until he is in a position to assume greater responsibilities. It is expected that the young engineer will be willing to undertake any reasonable assignment that will enable him to gain practical experience in manufacturing, shop and laboratory practice, field operation and in the drafting room. It is assumed that he will be willing to work with ideas submitted by others until he has had a thorough working knowledge of the business and is in a position to submit ideas of his own. He must understand that like any other professional man, he must continue to study and learn, in order to keep up with changing methods and new processes and advancement in the branch of engineering in which is is working.

In these days we hear a great deal about the importance of communications. Our most important communication is, of course, the written and spoken language, which is the most effective and flexible means of expression in our human relations. In addition to this means of communication, however, the engineer is also involved in the language of mathematics and in the language of graphics. Design engineers and engineering draftsmen particularly use the language of graphics, or, as it may be called, geometric illustration as a

(Left) This McCormick baler will bale up to 10 tons of hay an hour, of 15 x 19-in bales. *(Right)* This McCormick side-delivery rake was designed for tractor operation and will rake the heaviest hay at high tractor speeds.

means of communication to express their creative ideas. By means of mechanical drawings, engineers express to others the complete specifications for analyzing, building and manufacturing new products or improvements. Thus in industry we consider the basic function of engineering to be design. In order to design machines for others to test, manufacture in quantities, and sell, we must have draftsmen and graduate draftsmen who we call designers.

It is a common experience to step into a chief engineer's office to find at one corner of his office a drafting table containing some of the instruments of his profession. Obviously the chief engineer has long ago graduated from the responsibilities of the drafting board, but it is quite apparent that he still uses this means of expression in order to convert his ideas into concrete evidence of design which he can communicate to others. There is no short cut to experience and for a man to be an experienced design engineer or executive in engineering, he must have the experience which is gained in the actual design and drafting of product components. This development of experience is of course true in other fields than engineering. For example, the B-32 bomber pilot did not fly a four-engine plane until he had mastered the complexities of the single-engine trainer.

NOT "CHAINED TO A DRAWING BOARD"

This is all so elementary that it may be wondered to what conclusion I am leading. It involves a situation which causes us considerable uneasiness. As is generally known, engineering design can only be developed by the medium of drawing. We find, however, in attempting to fill many positions in the design groups, that it is extremely difficult to interest young engineers in this type of basic activity. While there may be other reasons for it, we know that in one instance the faculty of an engineering school has warned students not to take a drafting job and so become "chained to a drawing board". We have heard, but have not substantiated, a rumor that mechanical drawing and descriptive geometry are subjects to be deleted from the engineering curriculum of one leading university. I cannot state too emphatically that I have never yet, in my years of experience, seen any engineer "chained to a drawing board". We are very quick to evaluate an individual's ability to assume greater responsibilities, and it is, therefore, not only to his, but to our interest, to advance him to a responsible position as soon as his experience and ability warrant.

The disquieting evidence of a lack of understanding in certain educational groups, relating to manpower needs in industry, as aggravated by the conviction of some college men that sales work offers a much more remunerative and much less demanding field of work. Only under certain economic conditions may this be true. We continue to be alarmed, therefore, at the high proportion of sales engineers which are produced through the engineering colleges of the universities. If we have the shortage of graduate engineers which everyone is currently bemoaning, how much more concerned must we be if we are to face the fact that only a few of this small group wish to become associated with functions by means of which new products are conceived. With sincerity I urge engineering students to consider the possibilities of product design as a field in which to develop an engineering career. The satisfaction which results from creative effort is most readily gained from this field of engineering.

Certainly the comparative performance of individuals in industry is dependent upon many factors relating to mental equipment and temperament, but it may be possible for the educators to impart to their students an improved philosophy of approach to a problem. It is generally true that men graduating from engineering schools today have learned to accept things as they are rather than to inquire into the reasons for a given situation. New ideas and new products are born of the inquiring mind which observes and reasons, rather than accepts the practices of the past. If the student during his college training will develop a questioning attitude rather than an indifferent attitude which accepts things as they are, he will during the practice of his profession be able to contribute vastly more to the future technological advancements of his profession.

The young graduate engineer will find as he takes his first engineering position in industry that he will have very little trouble in making himself at home. Most companies are well aware that he may be confused and perhaps apprehensive of the many ramifications of the average-size engineering department. Accordingly he will first be exposed to an orientation period where answers will be given to many of the questions which he has. In some companies a regular planned engineering orientation course is provided. A course of this kind will seek to acquaint him with the company and the products it produces. He will be given an understanding of all phases of engineering and he will receive a clearer conception of how engineering responsibilities are related to other company functions. He will receive an understanding of the company's policies, employe benefit plans, manufacturing operations and product distribution. Detailed information concerning the specific engineering operations is generally included. Such information will cover a description of the operating and staff departments relating to product engenereing as well as the experimental and test groups. Opportunities for further study and training may also be outlined to him. Thus the young engineer will be well grounded in the basic fundmentals of his company and be ready to start his career by tackling his first assignment.

INDUSTRY RESPONSIBILITY TO ENGINEERS

Most industries are well aware of their responsibilities to their employes and particularly to their graduate engineers and they are constantly encouraging their creative ability to bring forth ideas which ultimately find their place in finished products. Certainly we know that the prime responsibility of industry is to utilize fully the talents of each individual, give him an opportunity to learn and to grow, and to encourage him to accept responsibilities which are limited only by his own ability and temperament.

It would be possible to enumerate further responsibilities of the young graduate engineer which, when combined with the responsibilities of industry, would add up to a successful association that will continue to produce technological advancements. However, I will consider this address a success if I have only been able to impress you with the advantages and the many opportunities that exist in design engineering. Today, more than ever, the opportunities in this field are unlimited. The great need for new and improved products has brought about an increased demand for designers who have imagination and ingenuity and who can utilize these qualities in creative design. Naturally we do not expect each designer to have all of the *(Continued on page 684)*

Minimum Air Flow Requirements for Drying Grain with Unheated Air

George H. Foster
MEMBER ASAE

MECHANICAL ventilation with unheated air may be used for drying grain and offers certain advantages over heated air. This method is usually considered less expensive (except possibly for the large grain producers), requires less supervision, and generally presents less fire hazard than drying with heated air. However, the effectiveness of unheated air drying is dependent on weather conditions.

In addition to the uncontrollable weather factor, the moisture ranges through which grain is to be dried and the rate at which the drying air is supplied are important factors influencing the effectiveness of unheated air drying. The air-flow rate used greatly affects both the equipment required and the operating cost. For example, increasing the rate of air flow from 2 to 4 cfm per bu through the same depth of grain will increase the power required about six fold, while the drying rate can only be doubled. Thus it becomes important to establish the minimum rate of air flow which can be expected to dry the grain without objectionable quality deterioration during the drying process. Actually the controlling factor is the maximum length of time the grain can be held with excess moisture before drying is completed.

This paper is a progress report of a series of five tests conducted to determine the air flow rates required for drying wheat and shelled corn with unheated air under Indiana weather conditions. Also included in the tests was a comparison of the effectiveness of continuous and intermittent ventilation for unheated air drying.

TEST PROCEDURE

Eight lots of grain of 16 bu each were used in each test series. Three test series were run with shelled corn and two with wheat. The shelled corn tests were conducted in the fall of 1950, 1951, and 1952, and the wheat tests in the summer of 1951 and 1952.

Air-flow rates chosen for the drying tests ranged from a high of 4 cfm per bu, which previous experience had shown was usually adequate, down to a minimum of ½ cfm per bu. The air-flow rates used for the 1950 shelled corn test and the 1951 and 1952 wheat tests were ½, 1, 2, and 4 cfm per bu. For the 1951 and 1952 shelled corn tests, air-flow rates of 1, 2, 3, and 4 cfm per bu were used.

The initial grain moisture content of the test lots was approximately 25 percent for shelled corn and 20 percent for wheat. These moisture levels were selected as being near the maximum moisture level at which the respective grains would ordinarily be harvested. Air-flow rates satisfactory for drying grain at these moisture levels would be more than adequate for grain at lower initial moisture levels.

One fan was operated continuously and supplied air to 4 lots of grain at the four selected air-flow rates. A second fan was controlled with a humidistat and operated intermittently. This fan supplied air to four lots of grain at air-flow rates identical to those supplied by the fan operated continuously. The intermittent fan operated only when the relative humidity of the air was below 70 percent in the tests in 1950 and 1951. The controlling point was raised to 85 percent relative humidity in the 1952 tests.

Air volume was controlled in the first series of shelled corn tests by setting the static pressure in the air-entrance plenum according to the known relation between resistance pressure, air flow, and depth of grain. In later tests, volumetric measurements of the air with a vane anemometer were also made. Although the precision of the air-volume measurements was not established, the measured volume was approximately that predicted from the static pressure reading. The air-flow rates were based on the number of bushels by volume at the initial moisture level.

Results of the drying tests were determined from samples drawn from each lot of grain with a standard sampling probe. Moisture content, viability, fat acidity, and commercial damage determinations were made from the samples. Sampling was done at varying intervals depending on the rate of drying and the rate of change in the condition of the grain. The grain was weighed when the test started and again when removed from the test bins. Grain temperatures were taken weekly with three thermocouples spaced uniformly down the vertical centerline of the bin.

EQUIPMENT

The tests were made in two identical bins of four compartments each. Each compartment was 2 ft square and 6 ft deep. A false perforated floor was installed one foot above the bottom of each compartment leaving a grain depth of 5 ft. Each bin was equipped with a small multivane blower driven by an electric motor. The fan delivered air to a plenum which served each of the four compartments. An adjustable slide was installed over a series of orifices between the fan plenum and the individual compartment plenum under the grain. The selected air volumes for each compartment were controlled by adjustment of the slide covering the orifices.

The equipment was located inside of an unheated building at the Purdue Electric Farm. The building, formerly an ear-corn crib, had slatted sidewalls. The drying air was drawn from the outside through metal pipes and the humidistat controlling the intermittent fan was installed outside of the building in a small instrument shelter.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1952, as a contribution of the Farm Structures and Rural Electric Divisions. It is a progress report based on cooperative research of the Purdue University Agricultural Experiment Station and the division of farm buildings (BPISAE), U.S. Department of Agriculture. Approved as Journal Paper No. 726, Purdue Agricultural Experiment Station.

The author — GEORGE H. FOSTER — is agricultural engineer (BPISAE), U.S. Department of Agriculture.

Acknowledgment: The author acknowledges the assistance of R. N. Robinson, agricultural engineer, U.S. Department of Agriculture, and the several members of the Purdue Agricultural Experiment Station staff who contributed to the project.

DISCUSSION OF RESULTS

The data collected on the 40 tests include some 1200 determinations of grain moisture content, germination, fat acidity and kernel damage. In addition, regular measurements of resistance pressure were made and a continuous record of psychrometric data charted. The data on drying rate and weather conditions shown in Figs. 1 and 2 are typical of that collected in each test.

The data on all of the tests were summarized as presented in Tables 1 and 2 for easier comparison between individual tests. The more important factors considered in evaluating minimum air-flow rates for drying grain and reported in Tables 1 and 2 are as follows:

1 The length of the drying period required
2 The amount of grain deterioration during drying
3 Method of ventilation—continuous or intermittent
4 Weather conditions during drying

Length of the Drying Period Required. The moisture content of both wheat and corn dropped in a fairly uniform manner until it was about 15½ to 16 percent. After it reached this level, changes were irregular and apparently were determined by atmospheric conditions more than by air-flow rates. An exception to this was the 1950-51 shelled corn tests in which the drying was obviously too slow except at the 4-cfm continuous rate. For this reason the length of the drying period reported in Tables 1 and 2 is the number of days required to reach 15½ percent, even though drying is not completed at this time. The tests did not show a relation between the rate of air flow and the drying time during this final period, that is, from 15½ to 13 percent moisture. The results indicate that continuous ventilation cannot be relied upon to reduce the grain moisture to a storable moisture level of 13 percent and that intermittent ventilation is usually more effective than continuous ventilation for drying the grain from 15½ to 13 percent moisture.

The time required to reduce the moisture content of wheat from 19.2 to 15½ percent varied from 5 to 74 days in these tests. In general, the drying time reported increased about in proportion to the decrease in the air-flow rates used. The two wheat drying test series were started July 18, 1951, and July 9, 1952. Soft red winter wheat of the same variety was used both years. In 1951 the wheat was harvested when the moisture content first reached about 20 percent, while in 1952 it had field dried to below 14 percent but was later rewetted by rain and dew

The time required to reduce the moisture content of corn from around 25 to 15½ percent varied from 18 to 168 days in the tests reported. The moisture removed from the shelled corn amounted to about 2¼ times that removed from the wheat. In the four tests with continuous fan operation and the same air-flow rates, the time required to dry the shelled corn averaged about three times that for the wheat for the same years. Although the average relative humidity was only slightly higher during the corn drying tests, the average temperature was 30 to 40 deg lower.

All the shelled corn tests were started late in the fall during the last part of the normal harvesting season. The 1950 test was started November 17, more than two weeks later than the 1951 and 1952 tests. The average temperature during the 1950 test was below freezing and averaged only 24 F during the first 42 days of the test period. The time required for drying in 1950 was about twice as long as that reported in 1951 when the temperatures were 33 to 41 F.

Grain Deterioration During Drying. The maximum length of the drying period, and hence the minimum air-flow rate for a given set of drying conditions, is limited by

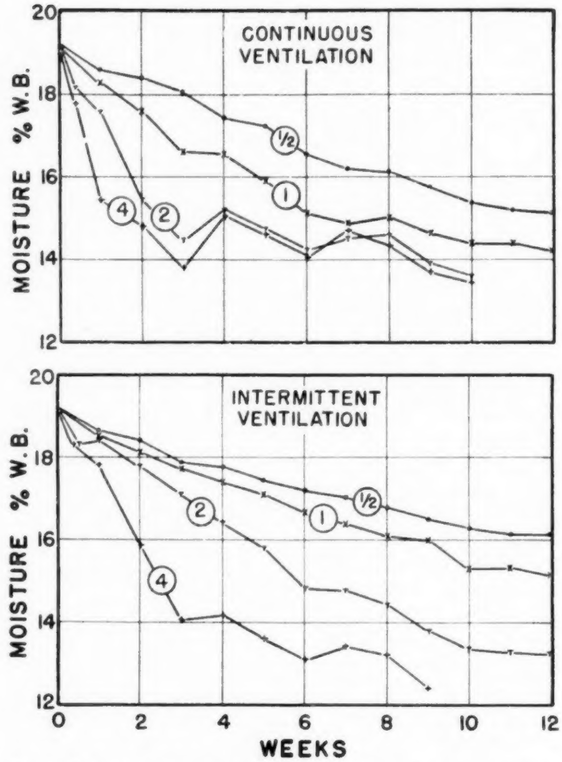


Fig. 1 Rate of moisture reduction of wheat ventilated continuously and intermittently at air-flow rates of ½ to 4 cfm per bu, July 16 to October 8, 1951

TABLE 1. SUMMARY OF WHEAT DRYING TESTS

(Initial Moisture, 19.2 percent)

Fan operation	Air flow rate, cfm per bu	Days to dry to 15½% moisture 1951	Days to dry to 15½% moisture 1952	Grain deterioration index * 1951	Grain deterioration index * 1952	Average Air Conditions: Temperature, deg F 1951	Temperature, deg F 1952	Relative humidity % 1951	Relative humidity % 1952
	4	7	5	1.1	0.3	74	77	72	70
Continuous	2	14	15	2.0	1.8	75	78	74	76
	1	41	24	3.8	3.5	72	77	75	74
	½	68	44	5.2	6.2	68	74	75	75
	4	15	12	2.7	2.3	81	82	54	64
Intermittent**	2	36	22	4.5	4.1	79	83	55	64
	1	74	40	6.8	5.8	75	79	54	60
	½	Drying not complete at end of test period							

* Grain deterioration index = decrease in percent germination ÷ 10 + increase in fat acidity index ÷ 10 + increase in percent commercial damage. The deterioration reported was for the entire test period.

** Intermittent fan operation limited to periods when relative humidity was below 70 percent in 1951 tests and below 85 percent in 1952 tests. Fan operated from 31 to 36 percent of total time in 1951 and from 48 to 61 percent in 1952.

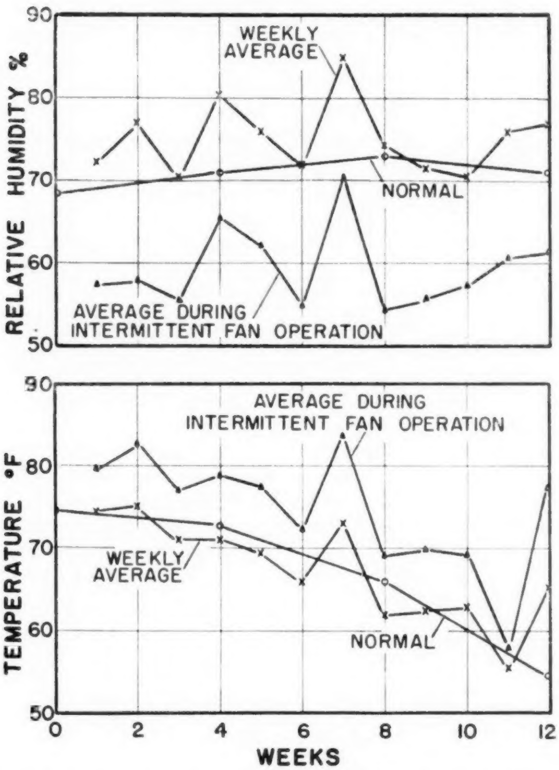


Fig. 2 Average weekly temperature and relative humidity during wheat drying tests, July 16 to October 8, 1951

the amount of grain deterioration that is acceptable. Grain deterioration may proceed to a point where mold growth seriously limits the passage of air through the grain. This occurred in two lots of shelled corn in 1950 which were ventilated at an air-flow rate of ½ cfm of air per bushel. Self-heating followed and the grain was removed from the test bin.

The three measures of grain deterioration used—viability, fat acidity, and commercial damage—were combined into a deterioration index with each measure having about equal weight. The deterioration expressed by this index increased with an increase in drying time in each test series. The relation of grain deterioration to drying time is shown graphically in Fig. 3. Although the drying time was reported as the number of days to reach 15½ percent moisture, the deterioration reported was for the entire test period.

Drying time appears to account for most of variation in grain deterioration in the wheat-drying tests. The deterioration rate in the corn-drying tests, while appreciably lower than that for wheat, varied widely between tests. The initial condition of the corn when harvested ranged from good quality corn in 1951 to exceptionally poor quality with a high percentage of immature or "chaffy" corn in 1952. This undoubtedly accounted for some of the variation.

A deterioration index of 2 was arbitrarily chosen as the maximum permissible for establishing minimum air-flow rates for satisfactory drying. For wheat, this limit was exceeded only when the drying period extended beyond 12 to 14 days. This limit was not exceeded in any of the corn tests where the moisture was reduced to 15½ percent within 30 days. The slower rate of deterioration in the corn may be due to inherent differences in the resistance to deterioration of corn and wheat, but more likely to differences in the air temperatures prevailing during the wheat and corn-drying tests. The corn also had a higher initial moisture—a condition normally considered conducive to higher deterioration rates.

After about 10 days of drying, visible mold formed on the surface of those lots of wheat that had not dried to about 15½ percent by that time. The appearance of mold on the wet shelled corn occurred after about 20 days. The moldy wheat lacked the luster of clean wheat and formed an objectionable dust when handled after drying was stopped. This dusty condition was not considered as commercial damage by the local grain inspector. The mold damage on the corn, if serious enough, was counted as commercial damage.

Continuous or Intermittent Ventilation. Continuous ventilation was more effective for drying high moisture grain to the 15½ percent level. For further reducing the moisture content below 15½ percent, intermittent ventilation was more dependable and faster in most of the tests. In the 1951 tests, the drying time for reducing the moisture content of the grain to 15½ percent with continuous ventilation was approximately one-half that for intermittent ventilation at the same air-flow rate. Increasing the controlling point of the humidistat from 70 percent relative humidity in the 1951 tests to 85 percent in the 1952 wheat tests altered this relationship very little. However, the drying time was reduced in the 1952 shelled corn tests when the controlling point of the intermittent ventilation was raised to 85 percent. This reduction was more evident in the tests completed during the first part of the drying period when the relative humidity was below average.

The relative effectiveness of continuous or intermittent ventilation for drying grain of moisture contents below about 15½ percent was much more dependent on favorable

TABLE 2. SUMMARY OF SHELLED CORN DRYING TESTS

(Initial moisture 1950, 25%; 1951, 24.5%; 1952, 26.5%)

Fan operation	Air flow rate, cfm per bu	Days to dry to 15½% moisture 1950	1951	1952	Grain deterioration index * 1950	1951	1952	Average Air Conditions: Temperature, deg F 1950	1951	1952	Relative humidity, % 1950	1951	1952
	4	42	20	18	4.0	0.5	1.8	24	34	46	77	79	72
Continuous	3	--	27	26	--	1.6	1.8	--	34	45	--	80	76
	2	77	41	46	10.6	2.1	6.2	26	37	42	76	77	79
	1	154	**	**	28.7	8.9	11.7	31	33	38	77	82	84
	4	110	49	21	17.2	2.0	0.6	22	41	50	63	58	65
Intermittent	3	--	**	40	--	6.7	4.4	--	39	47	--	61	65
	2	168	**	**	46.7	10.8	6.8	34	39	45	62	61	67
	1	***	**	**	***	30.8	17.2	***	39	45	***	61	67

NOTE: Intermittent fan operation limited to periods when relative humidity was below 70 percent in 1950 and 1951 tests, and below 85 percent in 1952 tests. The fan operated 20 percent of the total time in 1950, 24 percent in 1951, and 69 percent in 1952 in the tests with the 4 cfm per bu air-flow rate.

* Grain deterioration index = decrease in percent germination ÷ 10 + increase in fat acidity index ÷ 10 + increase in percent commercial damage. The deterioration was reported for the entire test period.

** Moisture content above 15½ percent at end of test period of 24 weeks in 1950 and 12 weeks in 1951 and 1952.
*** Test discontinued after grain started heating.

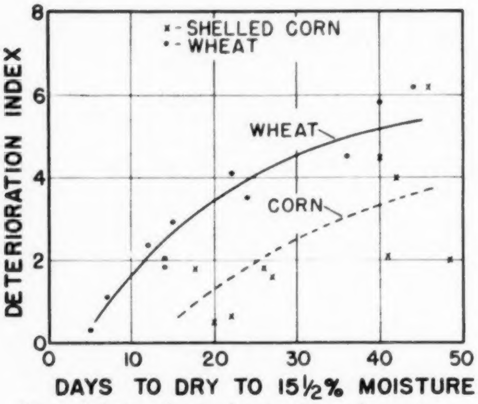


Fig. 3 Relation of grain deterioration to drying time

weather conditions than when grain moistures were higher. For example, in the 1951 wheat tests illustrated in Fig. 1, the lot ventilated at 2 cfm continuously reached 15½ percent moisture in two weeks but remained above 14 percent for nine weeks. In the lot ventilated intermittently at 2 cfm per bu, five weeks was required to reduce the moisture level to 15½ percent, but the 14 percent level was reached at the same time as that ventilated continuously. Contrasted to 1951, favorable weather occurred at the opportune time in 1952, and the lot ventilated at 2 cfm continuously was lowered to 13 percent in less than three weeks. Four weeks were required to reach the same point with 2 cfm intermittently.

Weather Conditions During Drying. The drying capacity as well as the drying potential of natural air is changing continually. There are periods in nearly every day when the drying capacity and potential are negative under Indiana weather conditions. An arithmetic average of temperature and relative humidity were not sufficiently precise for calculating relative drying efficiencies of the tests.

The average relative humidities for the various test periods varied only from about 70 to 80 percent. This variation was insufficient to explain the difference in drying rate between tests at the same air-flow rate. The difference between the average temperature in summer wheat drying and that in late fall corn drying apears to affect both the drying time and the drying efficiency. A complete analysis of the weather data and its effect on drying with unheated air is necessary for wider application of the drying data collected.

General Observations. The increase in commercial damage in all of the wheat tests was less than 2 percent and was not considered an important deterioration factor. Damage increases in shelled corn ventilated at the lower air-flow rates ranged from 15 to 30 percent.

Deterioration was generally higher in the top one foot of grain which dried last. The top one foot of wheat in the 1952 tests showed a deterioration index from 0.9 to 1.8 points higher than the average for the lot, when ventilation was continuous. For the intermittently ventilated lots, the difference ranged from 0.9 to 3.0 points. This difference was less than expected, but was even smaller in some of the shelled corn tests.

There was no evidence of "sick" wheat in any of the tests.

The loss in dry weight during the drying process was negligible in all the wheat tests. In the shelled corn tests, significant dry weight losses occurred in 1950 in the tests in which self-heating occurred. The self-heating started in early April after about five months of ventilation. These lots, removed shortly after heating started, showed a loss in dry weight of 2 to 3 percent. The three tests that were above 15 percent moisture at the end of the 12-week test period in 1952 showed dry weight losses of from 2.4 to 5.0 percent. No heating was observed in these lots. Dry weight changes in all other lots were less than 1 percent.

Measures of static pressure and air volume showed that the static pressure increased as the grain dried. In order to maintain the initial air volume, it was necessary to increase the static pressure periodically throughout the drying period even though the depth was reduced as much as 20 percent from shrinkage.

SUMMARY

1 The minimum air-flow rate for drying grain with unheated air is largely dependent on the limits of grain deterioration that are acceptable. For Indiana conditions, the minimum air flow for drying wheat from 20 percent to 15½ percent moisture without serious deterioration appears to be about 2 cfm per bu; 3 cfm per bu appears to be adequate for drying shelled corn from 25 to 15½ percent moisture in moderate fall weather.

2 The amount of grain deterioration during drying was closely associated with the length of the drying period and the temperature of the drying air.

3 The number of days required to dry grain to 15½ percent moisture with continuous ventilation was only about one-half that of intermittent ventilation where the fan operation was limited to periods when the relative humidity was below 70 percent. Raising the control point to 85 percent in 1952 reduced this difference in shelled corn tests, but had little effect in wheat tests made under summer conditions. A combination of continuous ventilation for grain above 15½ percent and intermittent ventilation for grain below that moisture appears to be the most effective method of fan operation.

New Graduate Engineer

(Continued from page 680)

abilities required to produce the finest designs. However, the capability of one individual complements the capability of another so that each engineering organization operates as a team in solving the problems of design. There are many opportunities for advancement in design engineering and I can personally assure the young engineer that there is plenty of room at the top.

It is impossible to overemphasize the advantages the young graduate engineer will have if he accepts employment in industry with the right attitude. Naturally he is proud to be a graduate engineer, and he has every right to be so. However, he should remember that he has much to learn. Even the greatest of men have realized their deficiencies and have been humbled by them. So enter industry with an inquisitive mind. If a particular assignment seems too trivial, one should remember he may learn something by doing it, and perhaps it was assigned to him for that reason. One should keep his ears and eyes open and remember there is still no good substitute for experience.

Above all, the new graduate engineer should choose carefully and remember that in this period of many opportunities, the only limiting factors are within himself.

Elastic Properties of Curved Rafters

Henry Giese and John H. Pedersen
FELLOW ASAE ASSOC. MEMBER ASAE

THE curved-arch type of rafter construction has long been popular due to its attractive appearance and self-supporting nature which leaves a mow space free of obstructing braces and posts. The curved shape is obtained by forming laminated rafters either of strips which are bent to the desired shape making laminations parallel to the roof slope, or of relatively short boards with one edge sawed to the desired curve and joined together to form laminations perpendicular to the roof slope. Opinions differ as to the relative merits of the two types and most effective methods to be used in construction.

This study was undertaken to make comparative tests of bent and sawed curved rafters to determine relative efficiency in the use of materials, cost of production, and strength and stiffness under conditions met in farm structures. Different designs of rafter and methods of fabrication were investigated to secure information for use in on-the-farm construction.

Several investigators report increases in stiffness and ultimate strength obtained by gluing, rather than nailing, the component members of the rafters.

From tests of 10-ft-gage lengths of laminated rafter sections by applying a concentrated load to the center of the member, Giese and Anderson (1)* found that a glued rafter of five 1 x 4-in strips laminated and bolted was 2.6 times as stiff as an unglued specimen of the same type, and that a glued rafter (not bolted) was 3.5 times as stiff as an unglued specimen of the same type. At the time the tests were made, most curved rafters were made of five 1 x 4's laminated, sometimes nailed and bolted but frequently nailed only. Later tests (3) of the unbroken portions of the above rafter sections confirmed the superiority of the glued rafters.

Further emphasis of the effect of glue in construction is found in the report by Wilson (7).

Martin (3) tested solid beams, seven-ply commercial rafters and straight laminated glued beams of six and seven plies, and found that glued members with continuous outer tensile laminations had stiffnesses equal to that of a solid member of the same dimensions.

In his flexural tests of six types of nailed sawed rafters, using one replication of each type, Molander (4) found a considerable increase in ultimate strength when the tension sides of the joints were strengthened by nailed steel straps.

Oates (6) reviewed the history of curved roofs, requirements of barn framing, barn sizes, and wind pressure distributions. He then analyzed the effects of dead, snow, and wind loads upon gothic roofs for 34, 36, and 40-ft wide barns, considering mow floor to ridge and sill to ridge types of construction. He also considered constant depth and varying depth rafters of the bent type.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1952, as a contribution of the Farm Structures Division, and the regional RMA Project NC-4, The Selection and Utilization of Building Materials. Journal Paper J-2291 (Project 1036) Iowa Agricultural Experiment Station (Ames).

The authors—HENRY GIESE and JOHN H. PEDERSEN—are, respectively, professor and research fellow, Iowa Agricultural Experiment Station.

*Numbers in parentheses refer to the appended references.

Plan EX. 5172 of the Northeast Plan Service specifies a sawed rafter for barns up to 40-ft wide composed of three 1 x 10's 8 ft long, with the outer edge sawed to the desired radius of curvature and fastened with 8d and 10d nails. The plan also shows bent rafters of five 1 x 4 plies, nailed and bolted, for barns up to 30 ft wide; for 32 and 34-ft wide barns every third rafter is of the sawed type.

Plan EX. 5688 of the Northeast Plan Service specifies three 1 x 10's 6 ft long cut to an arc and nailed together with eight 8d nails on each side of each joint.

Plan BG34X from the University of Wisconsin designates the use of three plies made from 1 x 8's 8 ft long cut to an arc in such a way that there is no waste and the resulting rafter has a uniform depth (see Type U3N8).

Hadlock recommends curved rafters for use 32 in on center with two inner plies of 1 x 8's 6 ft long cut to an arc on the outer edge and two outer plies of 1 x 4's 8 ft long (5). The rafter is nailed and bolted with $\frac{1}{2}$-in bolts 3 ft on centers.

Midwest Plan No. 72003 contains details for bent rafters using plies $\frac{25}{32}$ in by $1\frac{3}{4}$ in — seven plies for 34-ft, eight plies for 36-ft and nine plies for 40-ft barns. Cement-coated box nails 9 in on centers are recommended to clamp the casein glue which is applied in a one-inch band to one face of each ply.

A commercial type of bent glued rafter for farm barns is composed of seven plies of nominal 1 x 2 strips.

INVESTIGATION

On the basis of preliminary studies, flexural tests were designed to yield information indicating relative merits of several types of rafters and methods of fabrication which could be readily utilized on the farm. Records of labor and materials were kept. A completely randomized experimental design with six rafters of each of nine types was used.

The following symbols were adopted for identifying the rafter types:

B—bent
U—sawed, with uniform cross section
V—sawed, with varying cross section
N—nailed
G—glued
2, 3, 7, 9—number of plies
6, 8—length of sawed pieces.

Example: U3G8 represents a glued three-ply rafter composed of 8-ft pieces sawed so as to yield a uniform cross section.

Fig. 1 contains construction details for the sections described below.

Fabrication Details

B7N—Nailed, seven-ply bent section. The first ply was nailed to nailing blocks with 7d box nails which were clinched when the section was removed from the fabrication frame. The second ply was nailed to the first with 4d nails 18 in on center; the third ply was nailed to the second with 6d nails 12 in on center; the other plies were nailed with 8d nails 8 in on center; the first ply was then nailed to the others with 8d nails 8 in on center. One $\frac{3}{8}$-bolt was used approximately 6 in from each end of the section.

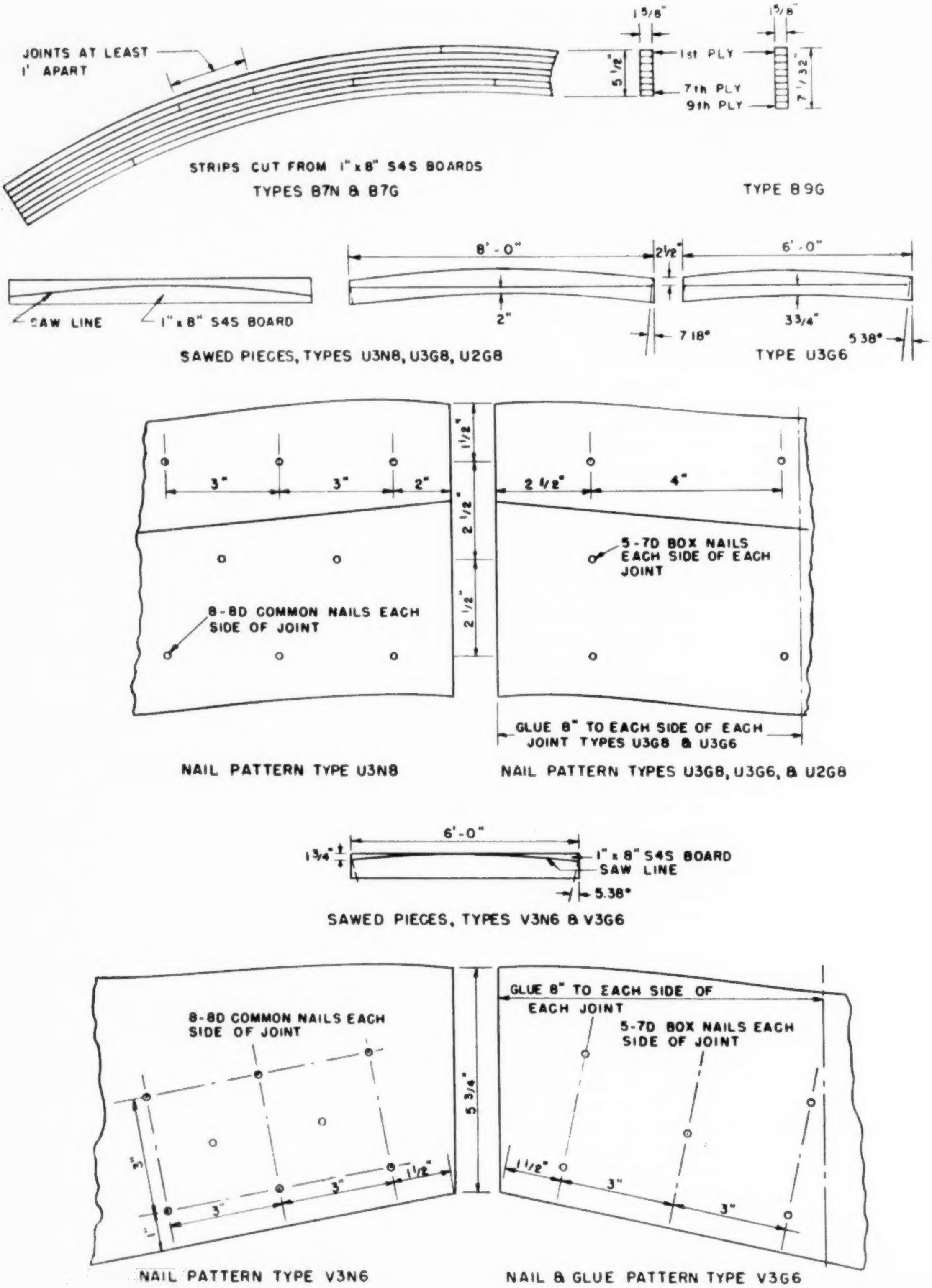


Fig. 1 Construction details for nine rafter types

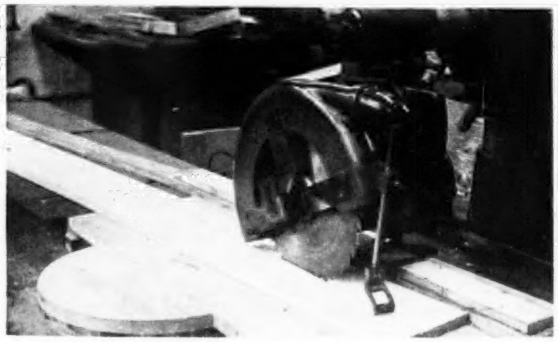


Fig. 2 Cutting curved edge for U-type sawed rafter

B7G—Glued, seven-ply bent section. The first ply was nailed in place with 7d box nails; the second ply was nailed to the first with 4d nails 18 in on center; all other plies were nailed with 7d box nails 12 in on center; the first ply was then nailed to the others with 7d box nails 12 in on center. Bolts were used as in section B7N. Glue was applied to each strip with a glue applicator before being placed in position for nailing. Glue was spread on one face of each strip.

B9G—This type was nailed, bolted, and glued the same as type B7G.

U3N8—Nailed, three-ply sawed rafter of uniform cross section using 8-ft pieces adopted from Plan BG34X from the University of Wisconsin, using an arbitrary nail pattern. The pieces were placed in the fabrication frame and nailed from the top.

U3G8—Glued, three-ply sawed rafter of uniform cross section using 8-ft pieces, similar to U3N8 above except that glue was spread with a brush 8 in to each side of each joint on both faces of the middle ply, and the inside face of the top and bottom plies; a 7d box nail pattern was used.

U3G6—Glued, three-ply sawed section of uniform cross section using 6-ft pieces, similar to U3G8 except for the length of pieces.

U2G8—Glued, two-ply sawed rafter of uniform cross section using 8-ft pieces; it consisted of two plies glued together throughout their length with the addition of 16-in long scab plates nailed and glued over each joint. In addition to the nails used at the joints four 4d nails were driven between each pair of joints.

V3N6—Nailed, three-ply sawed rafter of varying cross section using 6-ft pieces, copied from Type I of the tests conducted for Molander (4).

V3G6—Glued, three-ply sawed rafter of varying cross section using 6-ft pieces, similar to type V3N6 above except that the joints were nailed and glued.

Specifications for the sections tested were as follows:

Wood: No. 1 common Douglas fir, 1 x 8 S4S boards; average moisture content, 13.2 per cent.

Glue: cold water casein.

Bent sections: strips varying in length; cross section $^{25}/_{32}$ in by $1\frac{5}{8}$ in.

Uniform sawed sections: pieces nominally 1 x 8's, 6 or 8 ft long, cut as shown in Fig. 1.

Varying sawed sections: pieces nominally 1 x 8 by 6 ft, cut as shown in Fig. 1; cross section varied along the length of the piece.

Radius of curvature: 32 ft.

For the bent types, clear strips were selected for the outer plies. No joints occurred in the outer plies between the points of load application; joints were spaced a minimum of one foot apart. A curved fence on the radial arm saw was used to guide the boards for ripping the arcs (Fig. 2). Joints were 24 and 32 in apart when using 6 and 8-ft pieces, respectively, except for U2G8 in which the joints were 4 ft apart.

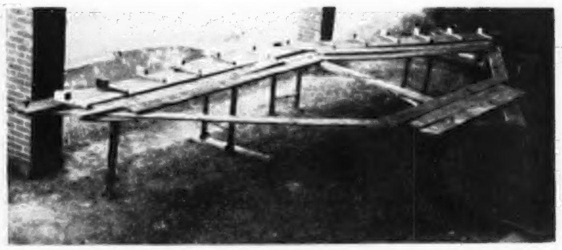


Fig. 3 Fabrication frame

Fig. 3 shows the frame constructed for fabricating the rafter sections.

Tests

Fig. 4 shows the loading diagram used in the flexural tests. Two equal concentrated loads were applied symmetrically 8 ft apart to a gage length of 19 ft 4 in. This loading system produced an 8-ft length of rafter subjected to maximum bending moment that allowed interpretation of failures with respect to joints, knots, and splits. Loads were applied with a hydraulic jack fixed to the test frame and were measured with two pressure gages.

The movement of a needle affixed to the center of each rafter section with reference to a strip of graph paper fixed to the test frame provided deflection readings.

Most of the failures in the bent sections occurred in the joints, due to weakness and poor glue bond near butt joints in the outer plies. The limit of the apparatus in deflection was reached before failure occurred in the B7N sections.

Failures in the sawed sections were a combination of flexure, torsion, shear, and transverse tension. Fig. 5 shows failure in a U-type section nailed at the joints, and Fig. 6 shows failure of a two-ply U-type sawed section glued throughout.

In sawed sections nailed or glued at the joints only, the transfer of stresses between adjacent pieces produces transverse tension which in nailed joints becomes critical at relatively low loads. Failures in the sections were due more to the action of this tension, combined with torsion and shear, than to flexural stresses.

Stiffnesses were calculated as the reciprocals of the regression coefficients for the straight-line portions of the deflection versus load curves. Table 1 contains the mean stiffnesses and breaking loads and percentage differences based on statistical significance. Fig. 7 contains the load-deflection curves plotted from the data.

Labor and material requirements and costs are tabulated in Table 1.

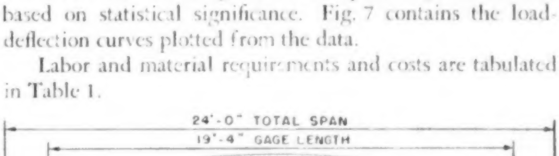
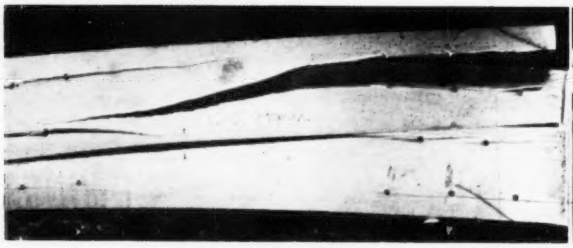


Fig. 4 Loading diagram



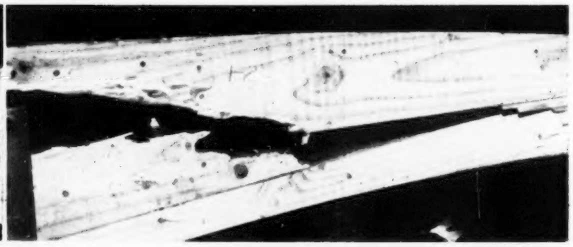


Fig. 5 *(Left)* Joint failure of U-type nailed section • Fig. 6 *(Right)* Failure of two-ply U-type section

CONCLUSIONS

The two-ply uniform-depth type of rafter was found to be the easiest to assemble because of the relatively small number of pieces and the large joint spacing.

The varying depth types were easier to assemble than comparable uniform depth types due to the smaller number of pieces involved. The bent sections, because of the large number of strips and the problem of holding them in place for nailing, were more difficult to fabricate than the sawed sections. Glued members were easier to assemble than similar sections nailed only because the application of glue and the driving of relatively few box nails required less work than the driving of many 8d common nails.

Joints in bent sections should be spaced further than 12 in apart.

Stress concentrations at the joints of sawed sections, which were not glued throughout their length caused them to act differently from homogeneous members in flexure.

Fig. 7 shows the average load-deflection diagrams for the nine rafter types. In addition to specifications for the various rafter sections, Table 1 shows comparative cost, stiffness and breaking load. Using the uniform depth two-ply glued section (U2G8) as a standard of comparison, the relative values of stiffness and strength per dollar of cost are as follows:

Rafter type		Stiffness per dollar	Strength per dollar
Bent, 7 ply, nailed	B7N	10	—
Bent, 7 ply, glued	B7G	57	52
Bent, 9 ply, glued	B9G	82	82
Uniform, 3 ply, nailed, 8-ft pieces	U3N8	50	43
Uniform, 3 ply, glued, 8-ft pieces	U3G8	108	77
Uniform, 3 ply, glued, 6-ft pieces	U3G6	107	76
Uniform, 2 ply, nailed, 8-ft pieces	U2G8	100	100
Varying, 3 ply, nailed, 6-ft pieces	V3N6	67	52
Varying, 3 ply, glued, 6-ft pieces	V3G6	89	76

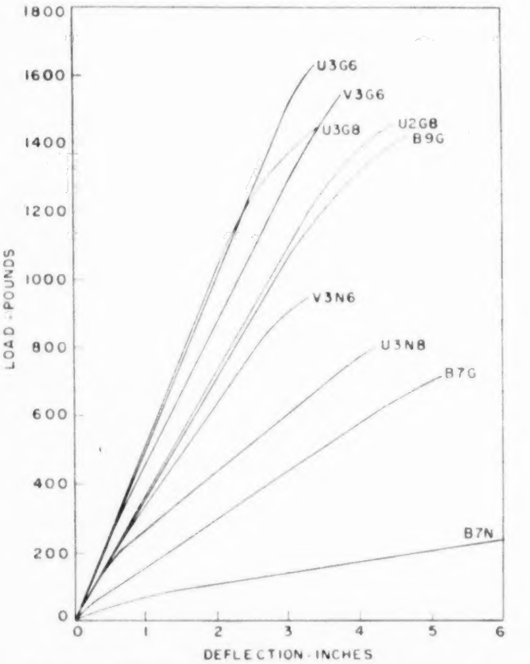


Fig. 7 Load-deflection diagrams for bent and sawed curved rafters

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TABLE 1. CHARACTERISTICS OF NINE RAFTER TYPES

	Type								
Characteristic*	B7N	B7G	B9G	U3N8	U3G8	U3G6	U2G8	V3N6	V3G6
Bent	x	x	x						
Sawed-Uniform cross section				x	x	x	x		
Varying " "								x	x
Glued type		x	x		x	x	x		x
Nailed type	x			x				x	
Number of plies	7	7	9	3	3	3	2	3	3
Length of pieces, ft		(varying)		8	8	6	8	6	6
Pieces, nominal size	(1 in x 2 in)			(		1 in x 8 in			)
Joint spacing, in	12	12	12	32	32	24	48	24	24
Size of nails (penny)									
Common	4,6,8	4	4	8			4	8	
Box		7	7		7	7	7		7
Nails, lb	2.2	0.7	0.9	1.4	0.5	0.7	0.5	1.8	0.7
Cost, $	.25	.09	.11	.16	.06	.09	.06	.21	.09
Bolts	2	2	2						
Cost, $	.18	.18	.22						
Glue, lb	-	0.6	0.8	-	0.5	0.5	0.7	-	0.5
Cost, $	-	.34	.46	-	.29	.29	.40	-	.29
Wood, fbm	28	28	36	48	48	48	35	48	48
Cost, $	4.06	4.06	5.22	6.95	6.95	6.95	5.07	6.95	6.95
Labor, man-minutes									
Cut material	22	22	26	20	20	22	14	16	16
Assemble	70	50	70	30	30	30	30	28	38
Cost, $	1.53	1.20	1.60	0.83	0.83	0.87	0.73	0.73	0.90
Total cost per foot, $	0.25	0.25	0.32	0.33	0.34	0.34	0.26	0.33	0.34
Percent of U2G8	96	96	123	127	131	131	100	127	131
Stiffness, lb per in	35	149	356	175	524	513	364	305	427
Percent of U2G8**	10	54	100	64	140	140	100	84	117
Percent of B7N**	100	426	1040	486	1470	1470	1040	871	1220
Breaking load, lb	-	719	1428	803	1456	1630	1466	948	1540
Percent of U2G8**		49	100	55	100	100	100	65	100

*Quantities of materials and costs based on 24 ft 0 in length of rafter and the following prices: wood, $0.145 per ft; box nails, $0.125 per lb; common nails, $0.115 per lb; glue, $0.57 per lb; and labor, $1.00 per hr.

**Percentages are approximate and are based on statistically significant differences of stiffnesses and breaking loads.

Nomographs and Data for Determining Winter Ventilating Rates for Poultry Laying Houses

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ASSOC. MEMBER ASAE

MUCH study has been devoted to poultry-house ventilation and a number of technical analyses have been published. However, complete information for rapid field design of poultry ventilating systems is not readily available from any one source. The object of this paper is to present certain design data and illustrate a practical field method of determining winter ventilating rates for poultry laying houses.

For a mathematical solution of moisture removal and temperature control problems the following equations are applicable to ventilating design:

Moisture-Balance Equation

$$W_a = W_r / w_i - w_o \qquad [1]$$

where W_a = air flow, pounds per minute

W_r = moisture to be removed from the house, pounds per minute

w_i = moisture contained in the indoor air, pound water per pound of dry air

w_o = moisture contained in outdoor air, pound water per pound of dry air.

Heat-Balance Equation

$$Nq_s = (\Delta t)\ (AU_{ar} + 60\ V_c) \qquad [2]$$

where N = number of chickens

q_s = sensible heat available, Btu per hour per hen

Δt = difference between indoor and outdoor temperature, degrees F

A = total exposed area, square feet

U_{ar} = average heat transmission coefficient for the exposed area, Btu per hour per degree Fahrenheit per square foot

V = air flow, cubic feet per minute

c = specific heat of air, Btu per cubic foot per degree Fahrenheit.

In order to apply these equations to actual conditions of variable temperatures and relative humidities, it is necessary to establish some basis for design. The following principles are considered to be fundamental in poultry ventilation design problems:

1 The rate of ventilation must be variable if the indoor temperature fluctuation is to be materially reduced. Ventilation will be a minimum during the coldest weather and will be increased for moderate weather.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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2 The critical temperature design period is the coldest period being considered for ventilation design. Calculations for the amount of insulation should be based on this period.

In view of these two statements, the design data for use during the lowest temperature design period is evaluated as follows:

Estimated Data for Lowest Temperature Design Period. In order to solve the heat balance equation, it is necessary to determine the inside and outside design temperature, the sensible heat available, and either the AU_{ar} value or the minimum rate of ventilation applicable to this critical period.

The minimum indoor design temperature is considered to be 30 F (1)*. This value is chosen as the minimum air temperature in order to prevent freezing of water pipes and fountains. Also if 30 F is accepted as the minimum house temperature, the house should be rather comfortable for the workmen during the day when the temperature is generally several degrees higher.

An analysis of 12 years weather data at Blacksburg, Va., indicated that a minimum outdoor design temperature of 5 F would be satisfactory for poultry ventilation design in that area (2).

Sensible heat production for various sizes of laying hens at approximately 40 F is presented in Table 1. Sources of information and methods of calculation are indicated below the table. Latent heat in the respired moisture was subtracted from the total heat to obtain sensible heat. Ota (3) suggested that additional latent heat should be subtracted since some moisture diffuses (not perspires) through the hen's body and that some moisture evaporates from fresh droppings. As no estimates of these values were available, no attempt was made to apply them. However, it appears that additional heat from other sources may equal or exceed this sensible heat loss. These sources include heat (*a*) generated in litter, especially if deep litter is used; (*b*) transferred from ground through floor, especially during the colder periods, and (*c*) produced by hens, heat production being greater at lower ambient temperatures (4).

TABLE 1. HEAT PRODUCED BY HENS*

Average weight of hen (pounds)	Latent heat in respired moisture†	Sensible heat available‡
3	1.8	35.0
4	2.5	42.9
5	3.1	50.4
6	3.7	57.5
7	4.4	64.0

*Heat in Btu per hour per hen.

†Calculated from basal metabolism experiments as reported by Barott and Pringle (5).

‡Calculated from formula, Btu per hour = 16.4 (pounds live weight)$^{0.734}$. This formula is a modification of a formula presented by Brody (6) and applied generally to many types of animals, including chickens. The constant, 16.4, was determined by use of recent data reported by Ota et al (4) for 5-lb hens at about 40 F. The latent heat of column 2 was subtracted from the total heat obtained.

In addition, residual heat in the structure will help to maintain the temperature during short cold periods. Also,

*Numbers in parentheses refer to the appended references.

sensible heat released by the hen's body should not be transferred to the litter during this period, as assumed by some writers, since the litter temperature will probably be higher than the 30 F minimum house temperature.

Having estimated the design temperatures and sensible heat available, it is necessary to determine the amount of insulation or a minimum ventilating rate in order to solve equation [2]. If the insulation is determined first, it will be necessary to evaluate the minimum ventilating rate after equation [2] is solved; thus it appears that a minimum ventilating rate should be established.

Suggested methods for establishing the minimum ventilating rate are as follows:

1 An arbitrary rate may be set. Experience indicates that about ½ to 1 cfm per hen may be a satisfactory minimum.

2 The ventilating rate necessary to prevent condensation on interior wall surfaces during the critical temperature design period may be used. Edgar's (7) chart for determining wall-surface condensation will be helpful when using this basis. The minimum ventilating rate will be the air flow required to maintain the design conditions used on Edgar's chart.

3 The ventilating rate necessary to remove the moisture respired by the poultry may be used as the minimum. Unless this moisture is removed, the indoor relative humidity would increase and ultimately condensation would occur. A method of determining the rate of ventilation necessary to remove the respired moisture during the critical temperature period is presented later in this paper.

With the preceeding information determined, equation [2] may be solved for the critical temperature design conditions.

In order to solve equation [1], the amount of moisture to be removed and the indoor and outdoor relative humidity must be estimated.

Since a major problem of poultry ventilation is maintaining dry litter, an estimated maximum design relative humidity will be used for design during the critical temperature periods. For poultry houses an absolute maximum of 90 per cent relative humidity may be permitted for short periods. Ordinarily a maximum of 80 per cent is suggested (8, 9). These maximums are in general agreement with the actual relative humidity reported in insulated houses (10, 11, 12). Minimum relative humidity is not considered, since under winter operation the lowest relative humidity obtainable will not be too low, unless heat is added.

Since an outdoor relative humidity of 100 percent exists during rainy or foggy periods, it is believed that 100 percent should be used for design during the coldest periods in the humid sections of the country.

For lack of better information on the moisture respiration of active hens for the coldest design period, respiration data reported from basal metabolism test (5) are used in this work (see Table 2). Moisture evaporation from the

TABLE 2. TOTAL WATER TO BE REMOVED BY VENTILATION*

Average weight of hen, lb.	Water to be evaporated from droppings†	Water respired at temperatures below 70 F‡ (5)	Total water to be removed by ventilation
3	31.5	4.3	35.8
4	36.3	5.8	42.1
5	42.2	7.2	49.4
6	44.5	8.6	53.1
7	50.1	10.1	(males) 60.2

*Water in pounds per day per 100 hens.

†Calculated from total moisture production values presented by Mitchell and Kelley (13) by subtracting respired moisture; then, using 77 percent (wet basis) as the moisture content for the droppings when voided and assuming 35 percent as the satisfactory moisture content of house litter, water remaining in droppings at 35 percent moisture content was subtracted.

‡Basal values from Barott and Pringle (5).

litter, which should be rather small during the coldest periods, is neglected.

It is recognized that the values presented are not fixed; the moisture produced by laying hens varies with the rate of lay, the diet fed, and environmental factors.

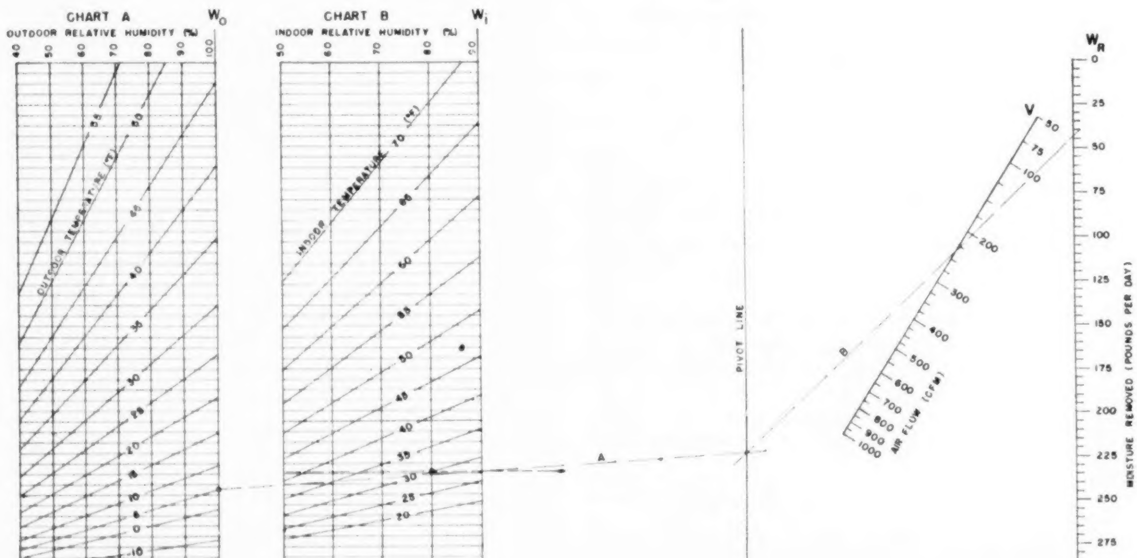

Fig. 1 Nomograph constructed to satisfy the moisture-balance equation (equation [1])

Construction of Nomographs. Two nomographs that satisfy equations [1] and [2] are presented in Figs. 1 and 2. In construction of the nomographs it was necessary, in order to read the air flow directly in cubic feet per minute, to use an approximate conversion factor for converting pounds of air to cubic feet. It is noted that the weight of dry air entering the house must equal the weight of dry air leaving the house. As moisture and heat are added to the air inside the house, the volume per unit weight of dry air increases. Thus the volumes of air and vapor entering and leaving the house are not equal. In constructing Fig. 1 a partial correction of this difference was made by using estimated indoor temperatures, corresponding to various outdoor temperatures, for converting pounds of air to cubic feet. The temperatures used were as follows:

For outdoor temperatures of below	15,	20,	25,	30,	35,	40,	45,	50,	55 F
Assumed indoor temperatures of	30,	35,	40,	45,	45,	50,	55,	60,	60 F

If the temperature deviates from these assumed values, the error would be rather small and may be neglected in practical applications.

In Fig. 2 the conversion factor used was 12.72 cu ft per lb, the volume of one pound of dry air at 45 F. The small discrepancy involved at temperatures other than 45 F may be neglected in general application work.

In order to illustrate a suggested design procedure for poultry laying house ventilating systems, two examples follow:

Example I. Design a ventilating system for a poultry laying house near Blacksburg, Va. Information is as follows:

Ventilation is to be adequate to remove respired moisture at all times.[1]

[1]As mentioned earlier the respired moisture does not include all moisture which may be evaporated in the house during the coldest design periods, 30 F indoor temperature. However, at least this amount of moisture should be removed continuously. A relatively low value may also be justified for fluctuating house temperatures, as assumed in this work, since most of the moisture should be removed during warmer periods when the ventilating rate is high.

Number of hens, 500
Average weight of hens, 6 lb
Size of house, 40 x 50 ft
Roof slope, 4 in 12

Materials:

Roof—asphalt shingles, 1 in solid sheathing, rafters, $^{25}/_{32}$-in fiber board under rafters (no ceiling)
Walls—$^{3}/_{4}$-in drop siding on 2 x 4-in studs 8 ft long
Windows—200 sq ft of single glass
Floor—concrete on well-drained soil.

The following information is taken from the presented data:

Outdoor design temperature, 5 F minimum
Outdoor design relative humidity, 100 percent (critical periods)
Indoor design temperature, 30 F minimum
Indoor design relative humidity, 80 percent (critical periods)
500 6-lb hens respire 43 lb of moisture per day (Table 2).

Using this information two dashed lines were drawn on Fig. 1. The minimum rate of ventilation is shown as 230 cfm. (Note that the intersection of the proper temperature and relative humidity must be located; see two black dots on chart A and B of Fig. 1, and projected horizontally to the right edge of each chart before constructing the dashed line A through the projected intersection at the right edge of chart.) This minimum rate of air flow should be sufficient to continuously remove the estimated respired moisture during the coldest design periods, provided the design conditions are maintained.

The heat transmission coefficients are (14):

$U_r = 0.19 \qquad U_w = 0.58 \qquad U_g = 1.13$

The exposed areas are calculated as follows:

Wall and gable area: 8 ft x 180 ft + 40 ft x 6.66 ft − 200 = 1500 sq ft
Roof area: 42 ft x 50 ft = 2100 sq ft
Window area: 200 sq ft.

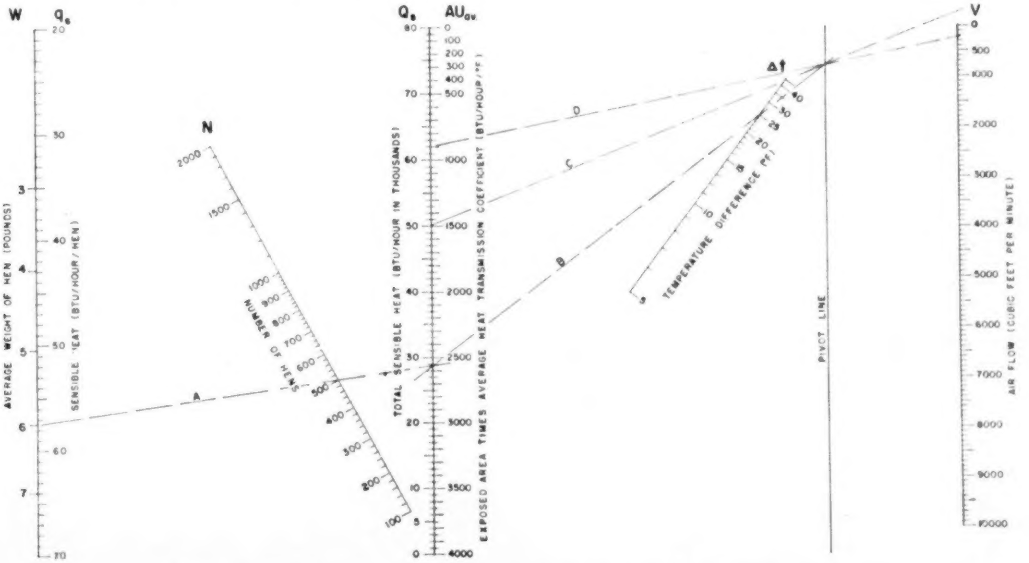

Fig. 2 Nomograph constructed to satisfy the heat-balance equation (equation [2])

The AU_{ar} value is obtained by the following calculations:

$$
\begin{aligned}
A_rU_r &= 2100 \times 0.19 = 400 \\
A_wU_w &= 1500 \times 0.58 = 870 \\
A_gU_g &= 200 \times 1.13 = 226 \\
\hline
AU_{ar} &= 1496
\end{aligned}
$$

On Fig. 2 the dashed line A is drawn for 500 6-lb hens to locate 28,750 on the Q_s scale. Line B is constructed from the Q_s scale through 25 on the Δt scale and to the pivot line. Line C, which is constructed through the pivot line point and 1496 on the AU_{ar} scale, falls below zero on the V scale. This shows that all the heat produced by the chickens is lost by conduction through exposed building surfaces and no heat is available for heating the ventilating air. If a ventilating system is to be installed, insulation must be added or the indoor temperature will fall below the 30 F desired. Using the previously determined minimum ventilating rate of 230 cfm, line D is constructed through the pivot line point and the maximum AU_{ar} value is seen to be 900.

Suppose 1-in fiber-type sheathing board, with 1/8-in hardboard protective cover, were added inside the studs. The new value for U_w would be 0.175 (14) and AU_{ar} would be reduced to 888. This is less than the value established by line D when using the minimum ventilating rate; thus this construction satisfies the insulating requirement for an outdoor temperature of 5 F and a ventilating rate of 230 cfm.

By using 28,750 on the Q_s scale and selected values on the Δt scale, additional points may be located on the pivot line. Drawing straight lines through these pivot-line points and 888 on the AU_{ar} scale will give ventilating rates for the selected temperature differences. In this problem, temperature differences of 5, 10, and 15 F yield air flows of 4300, 1780, and 910 cfm, respectively.

EFFECT OF VENTILATING RATES ON TEMPERATURE

Ventilating rates higher than 4300 cfm will reduce the temperature difference only slightly. Thus, higher rates should not be harmful from the standpoint of temperature. Considering drafts of air and economy, 4 or 5 cfm per hen may be the maximum desirable ventilating rate.

It should be pointed out that the use of 28,750 Btu per hr as the sensible heat available is not justified on the basis of the sensible heat produced by the hens. (Smaller amounts of sensible heat will be produced at higher temperatures.) However, solar radiation and warmer air temperatures do justify higher rates of ventilation. Actually, accepting the estimated data, the design is sound for the coldest design periods and the rates of air flow determined for higher temperatures should give the engineer an indication of thermostat settings and ventilating rates for the warmer periods of winter.

Example II. The first example was based on the coldest design period and a minimum ventilating rate. The total amount of moisture removed was not determined. It is usually desirable to determine the total moisture removed, but the design data that should be used for this purpose are not well established. Other investigators have used the mean relative humidity and temperature in determining the total water removed. Mean values are of doubtful accuracy. However, as an example, the mean temperatures and relative humidities will be used for obtaining a rough approximation.

Suppose it is estimated that a mean temperature of 40 F and a relative humidity of 80 percent will be maintained indoors during one of the cooler weeks of winter. Assume the outdoor mean temperature will be 25 F and the mean relative humidity will be 80 percent. If the air flow is estimated to average 1500 cfm, the water removed per day would be found as follows:

Locate 25 F at 80 percent relative humidity on chart A; project this value horizontally to the right edge of chart A. Locate 40 F and 80 percent relative humidity on chart B; project this value horizontally to the right edge of chart B. Draw a line through these points to the pivot line. A line through the pivot line point and 750 cfm on the V scale intersects the W_r scale at 164 lb per day. Multiplying by 2, the answer is 328 lb per day. Since the water to be removed from a house with 500 6-lb hens is 265 lb per day (Table 2), these calculations indicate that either the indoor relative humidity would be reduced or water would be evaporating from the litter more rapidly than water is added to the litter.

The above approximation of the total water removed is at best a rough estimate. Even though the weather conditions were known, the error involved in using the mean weather conditions may be considerable. Since the magnitude of the error is not known for a given problem, it is suggested that the design be based mainly on temperature and a minimum ventilating rate. With temperature as the basis for design, a high rate of air flow is indicated during the warm periods of winter. This should also be the best time for evaporating moisture from the droppings and removing the moisture from the house.

SUMMARY AND CONCLUSIONS

A summary of previous research data and two nomographs are presented. The nomographs can be used in the field for rapid design of poultry laying house ventilating systems. With the exception of outdoor minimum design temperature, information for design is presented. Two example problems illustrate the use of the nomographs. The first problem uses the coldest design period as a basis for design . The second problem illustrates a method of approximating total moisture removed from the house by use of mean temperatures and relative humidities.

Although a high degree of precision may not have been attained in the determination of design data, it is believed that the general values presented are sufficiently accurate to warrant their use for practical design of ventilating systems for laying houses. When the design data are more definitely established, the method and nomographs may be applied to the actual design work. With different design data the only scale which needs to be altered is the W scale on Fig. 2. Thus, if the designer desires, he may use the nomographs with design data established for his particular conditions. A more complete discussion of design data and problem analysis may be found in reference (2).

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(Continued on page 708)

A Low-Cost Hydraulic-Type Dynamometer

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BEING in need of a new dynamometer, in 1952 the agricultural engineering department at Kansas State College built a hydraulic-type dynamometer. Student labor and shop equipment on the campus were utilized for this purpose.

The main advantage of the hydraulic dynamometer was that it could be built in the college machine shop. The cost for material was approximately $290, including the hydraulic scale. Labor costs amounted to $465, most of which was student labor at a rate of 75 to 90 c per hr.

This dynamometer as shown in Fig. 1, was patterned after a dynamometer developed at Princeton University which has an internal cooling system. The KSC dynamometer was designed so that it could be driven either with a direct-connected power unit or by two V belts connected to a farm tractor. The multiple V-belt drive was used since it was a gift to the college from the manufacturer. The dynamometer is equipped with a 16-in-diameter impeller made from ½-in boiler plate with angle irons bolted radially on each side of it. Angle irons were also bolted radially to the sides of the housing. The cylindrical portion of the housing is constructed of ¾-in boiler plate which was rolled, welded and ends machined square by a railroad shop. The two hub assemblies which support the dynamometer assembly are equipped with three neoprene oil seals and a single-row radial ball bearing for each hub. The neoprene seals act as grease retainers and also prohibit water from entering the interior of the hub and causing damage to the bearings.

The cooling coils are of ½-in (OD) annealed copper tubing and are arranged in two independent sets of coils with the tap water entering at the top and leaving at the bottom. The amount of cooling surface necessary to keep the dynamometer water from getting too hot is determined from the maximum horsepower which the power plant is capable of developing and the desired rise in temperature of fluid in the dynamometer and cooling coils. Dynamometers of similar design have been operated at temperatures as high as 165F with no harm to the dynamometer; however, for heavy-duty operation a better upper temperature limit of 140F has been suggested. The power absorption capacity of the dynamometer is changed by varying the amount of fluid in the housing. This is accomplished by means of a Viking model ECH2 rotary-type pump which is capable of pumping fluid in either direction of rotation. The pump is operated by a 1/6-hp electric motor. A reversing switch is connected to the pump motor in order to change the direction of rotation. This permits the operator to load or unload the dynamometer by merely changing the direction of rotation of the pump by means of reversing switch on the instrument panel. The fluid used for loading and unloading is water treated with a Dupont rust inhibitor which also contains water-pump lubricant. It is stored in an 8-gal tank and reused. In order for the operator to see whether or not the fluid is flowing whenever the pump is operating, a flow indicator was mounted on the instrument panel near the pump motor reversing switch. The use of special fluid and equipment for loading purposes is, of course, not necessary; however, it was believed that less trouble from corrosion would be encountered. Venting of the dynamometer is important in order to prevent generating of excessive pressures inside the housing. This was done by means of a quarter-turn stopcock connected close to the center of the housing. A Bell and Gossett automatic air vent has been suggested as a better method.

The power absorption of a similar type dynamometer when completely filled with cool water has been determined by Princeton University to be $H = aN^n$, where H = horsepower; a = constant; N = rpm; n, an experimental constant = 2.92. Fig. 2 shows the power-absorption characteristics of the KSC dynamometer at various speeds when partially filled with cool fluid. It is interesting to note that this

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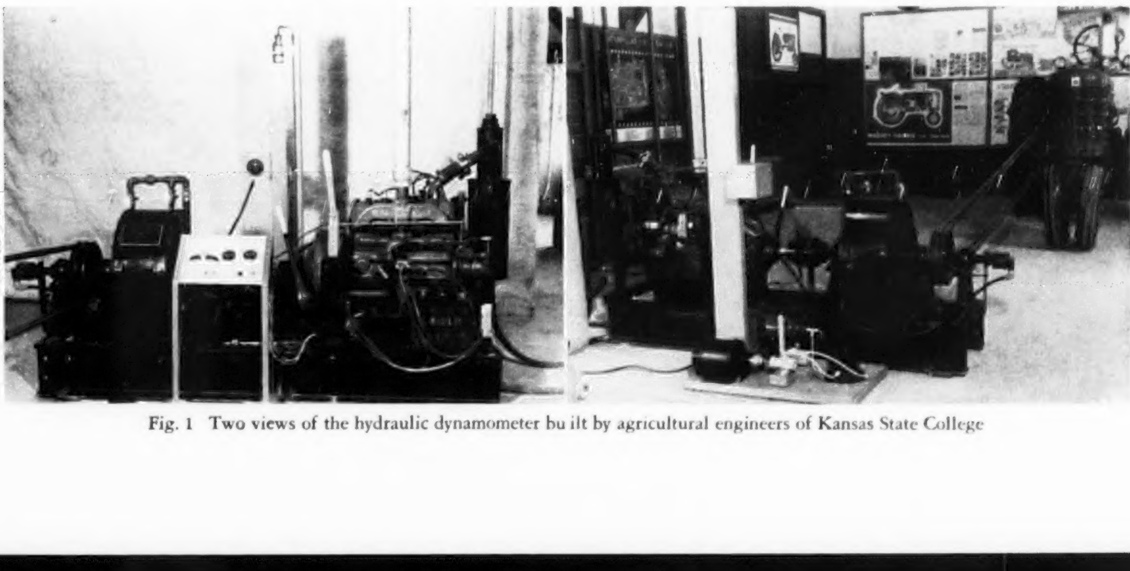

Fig. 1 Two views of the hydraulic dynamometer bu ilt by agricultural engineers of Kansas State College

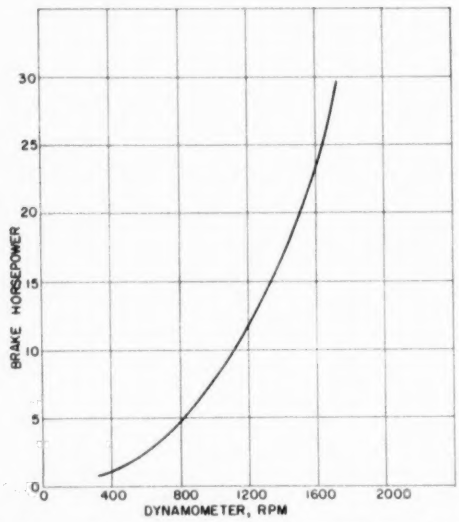

Fig. 2 Typical power absorption characteristics of the KSC dynamometer at various speeds, when partially filled with fluid

type dynamometer has the advantage of meeting a wide range of conditions. For example, it can be designed for a slow speed-engine, and at the same time it can be used for a higher speed engine of much greater power. Indicated horsepower and friction horsepower of an engine may be determined with this dynamometer by shorting out one spark plug on a spark-ignition engine or shutting off the fuel supply to one cylinder for a compression-ignition engine, and balancing the dynamometer with the remaining cylinders firing. From this information one can calculate the indicated horsepower of one cylinder.

According to Professor Sorenson of Princeton University, he has used a 16-in impeller dynamometer on a GM3-71 diesel engine at speeds varying from 700 to 1800 rpm and a Studebaker Champion engine at speeds between 1000 and 3400 rpm with satisfactory results.

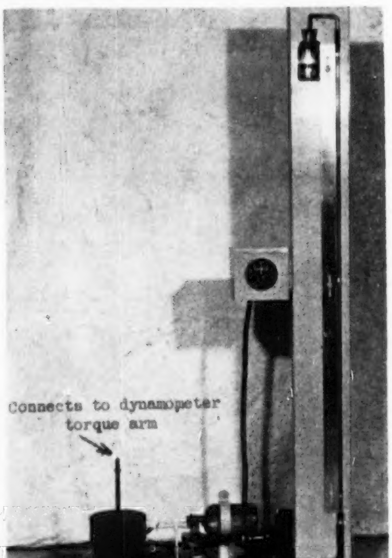

Fig. 3 Hydraulic scale developed for use with the KSC dynamometer

Another feature of interest on the KSC dynamometer is the hydraulic scale. This scale (Fig. 3) was patterned after one developed in the Sloan Laboratories at Massachusetts Institute of Technology. It eliminates the need of platform scales with weigh beams. It consists primarily of a stationary piston fastened to a base which is also the base for the oil reservoir. A movable cylinder which fits over the piston with a clearance of approximately 0.0005 in is connected to the lever arm of the dynamometer by means of thrust rod and ball-and-socket arrangement. Enclosing the cylinder and piston assembly is a cover over the reservoir.

The reservoir contains a mixture of SAE 20 oil and kerosene in equal proportions which is pumped into the piston and cylinder assembly with the same type and size pump as was used for loading the dynamometer. As the oil is pumped into the piston and cylinder assembly, the cylinder will raise to a pre-determined level where bleed holes in the side of the cylinder permit the oil to return to the reservoir and be recirculated by the pump. Any load on the dynamometer arm and cylinder is balanced by a hydraulic pressure acting on the piston. The hydraulic pressure is obtained by the throttling effect of the bleed holes in the movable cylinder. For equilibrium of forces, the load applied by the dynamometer must be balanced by the oil pressure acting on the cylinder. The cylinder will move until this equilibrium is attained. The pressure times the area of the piston is then proportional to the dynamometer load. The hydraulic oil pressure is then transmitted to a calibrated mercury manometer scale which is calibrated in pounds. The kerosene-oil mixture is separated from the mercury by means of a layer of distilled water.

The piston is spherical in shape so that, if the piston and cylinder assembly are not in exact alignment, the same area will be acted upon by the force of the lever arm and there is also less possibility of binding due to misalignment.

The manometer scale shown in Fig. 3 is approximately 42 in long and will handle a gross dynamometer load of 64 lbs. The stationary hydraulic piston has a diameter of 1.9761 in. With this size piston the load conversion factor for the mercury manometer scale is 1.5 lbs. force for one inch of mercury at 75F. The range of usefulness for the hydraulic scale can be increased by mounting an extended arm on the opposite side of the regular dynamometer torque arm on which counterweights can be added. In this way dynamometer loads which would otherwise exceed the range of the scale can be measured.

The length of dynamometer torque arm is 21.0084 in. Therefore, the formula for calculating brake horsepower is

$$\text{BHP} = \frac{N\ (\text{rpm}) \times \text{net force (pounds)}}{3000}$$

It should be mentioned that the research laboratories division of General Motors Corporation has conducted a series of tests relative to performance of a similar hydraulic scale. They discovered that, since the spherical-shaped piston also acts as a valve having viscous flow characteristics, the equilibrium position for the piston depends upon the oil temperature for any given load. (Continued on page 708)

Farm Equipment Steels

A Harvesting Machinery Engineer's Viewpoint

C. J. Scranton
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THIS paper is confined to a discussion of steels used in the design and manufacture of harvesting machinery, such as grain harvesters, corn pickers, hay balers, silage machinery, and the like. I do not profess to speak for harvesting machinery engineers and manufacturers as a whole; rather my remarks are based on the result of personal experience over many years with the design and development of kind of equipment mentioned. This experience has led to the belief that the problem of steel selection can be simplified and the whole industry benefited by improved availability of a comparatively limited number of steels, which are adequate to give satisfactory results and which could be more readily secured from both mill and warehouse stocks.

Harvesting machinery design and manufacture has its own peculiar problems. The machines are used for not more than 30 to 60 days each year but take quite a beating when they are in use. They must be profitable to both maker and user, and since weight and cost per pound are closely allied, it is necessary to consider steels which give requisite strength with lowest possible cost and least weight. It follows that carbon steels with high yield points are used wherever possible in the frame members and many other parts because these steels give the most satisfactory results. Alloy steels are generally avoided except in certain transmission gearing, drive shafts, etc., where strength and space limitations become the deciding factor

The harvesting machinery engineer is chiefly concerned with the design of frame structures, power-transmission parts, forgings, springs, tubing, sheets, levers and rods. He is also interested in such items as cutting sickles, chains (both link and roller), augers, universal joints, bearings, bolts, and the like, but these items are usually made by manufacturers who specialize in their production, and therefore they are not a major part of this discussion.

Frame Structures. Frame structures generally include the main frame, body skeleton, struts, reel support members, and the like. They are usually made of rolled steel channels, tubing, angles, or of formed metal parts or a combination of these items. A good designer will strive for stiffness without too much rigidity, because a well-designed unit will flex slightly without rupture, while a too rigid unit will have excess weight and cost without the guarantee of strength and long life where the tools are used over rough ground conditions.

Structural channels have a high resistance to bending in the vertical plane and are used in axle members, tongues, and other structures requiring this type of stiffness. They do not, however, make good torsion-resistance members by themselves and also must be used somewhat sparingly because of their weight per foot.

Structural tubing has a fairly wide application because of its higher carbon content which gives it a high yield point and relative stiffness. This tubing is available in rectangles, squares, rounds, and other miscellaneous shapes, and, when properly selected, combines great strength with light weight. The rectangular tubes are ideal for resistance to bending and also have considerable torsional strength. The rectangles or squares make desirable axle or frame structures, and the rounds give the maximum torsional resistance. This tubing can be bent with some limitations and can be welded quite satisfactorily. It also permits some machining operations. Mechanical welded tubing is also used in frame structures, but because of its lower carbon content does not have the strength characteristics of the structural tubing in the same size sections. It does, however, have somewhat better welding and forming characteristics.

Angles, small channels, and other small rolled shapes commonly known to the trade as bars are widely used in the industry, in both frame and body parts because of their sectional strength and the general ease of fastening parts to them by welding or riveting. These shapes are available in standard bar structurals as well as rerolled car axles in the 35-50 carbon class, and rerolled used rails in the 50-85 carbon class.

The higher range of carbon steels in the above shapes give a very stiff structure but present some limitations in welding, punching, and forming. This leads to the conclusion that the farm equipment industry could be better served by the general availability and use of a single class of steel, including angles and shapes in a 1045 carbon steel which can be readily worked in almost any form and which would still have good enough strength to give structural stability with light weight.

Formed or pressed frame parts are sometimes used where depth is required to give extra strength in bending and where weight can be saved against the use of a standard structural steel shape or where a fabrication of steel shapes is costly. These formed parts are usually made of flat hot-rolled steel in the 15-20 carbon range.

Power Transmission. Included in the power-transmission group are shafting, rocker parts, gears, sprockets, propeller shafts, and similar items. It is our belief that by far the greater number of parts of this type can be made of only four kinds of steel within the carbon steel range.

The first of these is a screw stock normally referred to as a free-cutting steel of the B-1112 class. This steel is used on parts where much turning or drilling is required and where strength is not the important factor. It is not generally recommended for major upset forging requirements although it can be hot and cold formed on simple operations. The steel can be carburized with a light case, but has some use limitations because of soft spots which cannot be avoided. The trend seems to be toward the replacement of this steel with C-1212 which is made by the open hearth instead of the Bessemer process.

The second steel we use is classified as C-1019 and is generally used in all parts where carburizing or carbonitrid-

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ing is required for wear purposes. It can be used in either the bar or forged form and makes satisfactory gears, sprockets, and like parts. Where best results are expected, a fine-grain steel is specified. In some cases, C-1018 is used as an alternate, but our experience has been that the higher manganese content of the C-1019 gives somewhat more dependable results.

The third steel recommended is C-1042 or C-1045 for general shafting and parts which are to be induction hardened. Roller bearings with limited loading will work well on this material as it comes, and it can also be hardened for short lengths to give still a longer wear factor when desired at localized points. It is usually procured in the cold drawn or the turned and polished shapes, and the diameter tolerances are close enough for practical use as the material comes.

Where maximum possible strength obtainable is desired in a carbon steel, we normally specify a cold-drawn bar in the medium-carbon range drawn with an extra heavy draft or strain tempered to increase the physicals. This steel can be machined in the treated form, has good strength characteristics, and is suitable for transmission shafting requiring a larger safety factor or reduction in size, spline wear, and the like

Propeller tubes, which generally transmit power from the power take-off on the tractor to the harvesting machine, require a uniform thickness, strong steel, especially produced for the purpose. The tube must be light to avoid whip and adequate in diameter to withstand torsional shock loads if the tractor clutch should be engaged quickly. These tubes are made from a 1025 carbon steel and cold rolled to increase their physical strength.

FORGINGS USED ON HARVESTING EQUIPMENT

Forgings. Forgings are usually used on harvesting equipment for jaw clutches, gears, steering parts, sickle guards, and small parts where good strength and special shapes are required. Most of these parts require carburizing or carbonitriding, and a C-1019 steel is suitable in many cases. Where higher core strength is required in the heat-treated part, a C-1035 steel may be the more desirable.

Springs. There are many types of springs used in harvesting equipment and they range from very small wire to ⅝ in or more in diameter in both the extension or compression coil types. Flat springs are also used. In nearly all cases, these springs are made of C-1065 or C-1095 steel, oil tempered, but for some purposes where the springs are not too highly stressed, they may be made of hard-drawn spring wire which is not treated after forming. Usually the higher carbon steel is heat-treated but may be used for wear strips in the as-rolled condition.

Mechanical Tubing. Mechanical welded tubing is generally used for rollers, exhaust and intake stacks, frame members which require severe bends, and like items. This type of tubing is recommended for rolls where reaming or other machining operations are necessary for close tolerance because it is usually under 0.20 in the carbon range. These parts are quite satisfactory where great strength is not required.

Sheets. For the purpose of this discussion, parts manufactured from sheets are divided into four classes, namely, stampings, cover sheets, coated sheets, and sheets for parts requiring drawing quality.

The major part of our formed parts, or those requiring minor drawing operations, can be made from cold-rolled or hot-rolled pickled and oiled sheets. This steel in the low-carbon range is improved by cold finishing and is of such a character that it will take an excellent paint job.

Cover sheets, which guide or house in the material to be harvested, are usually fastened to structural members. Here again the cold-rolled material, which is generally applicable to 18 gage and thinner, gives most excellent results. It can be formed, riveted, spot-welded, or arc-welded with facility.

Many of the sheet metal parts of harvesting machinery are subjected to wear by the rubbing action of abrasive material such as cornstalks, straw, etc., entering the machine, and, where the steel is not protected by zinc coating, the paint is quickly worn off. After a period of time, the worn spots become very rusty and the machine unsightly. Coated sheets are generally referred to as galvanized or galvannealed sheets. The ideal sheet for use where the machine is painted over all, is one with a tight coat which will not peel off in reasonable forming operations, and a dull coat which will permit good paint adhesion.

GEAR HOUSINGS REQUIRE DRAWING OPERATIONS

Other parts of harvesting equipment, such as gear housings, shields, etc., require drawing operations beyond the limits of the commercial cold-rolled sheets, and, in these cases, it is necessary to specify a refined low-carbon sheet with deep-drawing qualities.

Levers and Rods. Most of the levers and control rods are made of bars or rods of the C-1017 commercial quality class of steel. The levers or rods can be readily formed or forged.

Occasionally greater stiffness may be required on the levers or rods, and, in these cases, it is customary to specify a medium carbon steel such as C-1045.

I am aware that individual companies manufacturing harvesting equipment may have special problems and that some extension of the classes of steel discussed here may be necessary. It would seem, however, that some very distinct advantages would accrue to manufacturers of harvesting machinery if they would all use a limited number of steel classifications of which there are some sixty-five listed by the manufacturers of carbon steels alone. By close cooperation between the metallurgical, manufacturing, and engineering departments, we have found it possible to build a fairly complete line of harvesting equipment with a simplified program, and, in conclusion, may I suggest that some of the advantages would be as follows:

1 Simplification of warehouse control with less variety of steels to rack or store and record through the shop.

2 The know-how of bending, punching, and welding structural shapes of like carbon content.

3 Improved knowledge and better results in the heat-treating of a few kinds of steels.

4 Reduction in cost of finished products by increased efficiency in handling fewer classes of steel.

5 A more simplified program for the makers of steel as well as the users, and a resultant better availability of the steels required, together with a substantial saving in time lost in making substitutions.

6 Better inventory control.

7 Elimination of quantity extras by combining requirements.

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A Tillage Implement Metallurgist's Viewpoint

W. C. Bliesener

THIS paper is intended as a brief discussion of the steels used in the manufacture of agricultural tillage implements —plows, harrows, planters, cultivators, and other ground-working equipment. To perform their work these implements must be stiff and yet flexible to adjust to uneven operating conditions. The parts must resist abrasive wear and take the abuse of the hazards of earth tillage and the impact shocks of high-speed transport over rough fields and roads. High-speed transport behind the new faster tractors has created new demands on the designer and fabricator.

My experience with these implements is as a metallurgist rather than a designer; and the metallurgist's function is to interpret the properties of various steels suitable for a given application. These steels must be considered under several conditions: physical properties of the material, cost, fabricating and heat-treating equipment available, cost of fabricating under given conditions and volume, and the experience and confidence of a manufacturing organization in handling certain types of steel.

There are over a thousand manufacturers of farm equipment, and probably most of these make some form of tillage tool or attachment. For this reason it would be difficult for any one to speak for this number of organizations, ranging from large corporations to small privately operated shops. These small manufacturers usually produce a product adapted to local needs, and for this reason are competitive to large corporations where products must be suitable to a wide variety of conditions. For this reason there is most likely a wide range of steel analysis used on similar parts in the tillage industry.

IMPLEMENT INDUSTRY USES FOR TYPES OF CARBON STEEL

It has been suggested that your society is interested in the simplification of steels used in farm equipment machines. In general these can be limited to four types of carbon steel for the tillage implement industry: low carbon, 0.10 to 0.25; medium carbon, 0.35 to 0.50; medium high carbon, 0.60 to 0.70, and high carbon, 0.80 to 1.00. Each group is readily available from mills and warehouses. The problem which complicates the selection of steels is the qualities in which the carbon steels are furnished and available. These are "merchant" or "commercial," and are furnished without extra price. Special bar quality has an extra of $7 a ton, and the A.R.R. and killed steels from $10 to $14 a ton. In addition to these, there are two types of steel which could be considered qualities—rerolled railroad car axles and rerolled rails. Both of these are suitable for use in the tillage industry and have price advantages under certain conditions.

Alloy steels are seldom used in tillage implements, partly because of their higher cost and because it has been possible to develop the necessary physical properties in carbon steels for satisfactory performance.

As carbon increases the steels become stronger and stiffer, but the cost increases, because of analysis and quality extras, and higher carbon steels become increasingly difficult to machine, weld and forge. For this reason I will discuss the use of steel in the order of increasing carbon.

Of the low-carbon steels, sheet steels are generally produced in 1010 carbon grade and the hot-rolled commercial quality or hot-dipped galvanized are suitable for the majority of tillage implement applications. These sheets are adaptable to simple forming operations, weld easily and are readily available. Cultivator shields, seed and fertilizer cans for planters are examples of the largest use of this type of material. Seed and fertilizer tubes for planters and cultivators require severe cold working for shaping, and for this reason a zinc electroplated cold-rolled sheet steel is desirable to resist corrosion. The required properties of temper, size and tolerance, and coating are negotiated between the buyer and supplier. With the increasing use of fertilizer, stainless steel, despite its high cost, may be justified for this application.

The low carbon steels of from 0.15 to 0.25 carbon are extensively used in the tillage implement industry. These are sometimes referred to as mild or machine steels. The desirable properties of these steels are good machining and punching under a wide variety of conditions, simple cold-bending operations, low cost, and good weldability. These steels forge easily and do not require close temperature control to prevent overheating and burning.

The so-called "cold-rolled" bars are furnished of this analysis unless ordered to specification. Cold-drawn bars are furnished to close size tolerance and are stronger and stiffer than hot-rolled steel of similar analysis. The close size tolerance makes them desirable for small drive shafts on planters and fertilizers.

STEEL SPECIFICATIONS TO BE REVIEWED

In the past, excluding the carburizing grades, 1015, 1017, 1020 and 1025 carried the same price extras for bars. A recent change in pricing will leave 1015 the lowest price, and 1017 and 1025 will be increased by $1.00 a ton, and 1020 by $2.00 a ton. For this reason there will be a review of specifications by most manufacturing organizations to determine the most desirable steel on a cost basis. These changes in pricing extras make the problem of steel simplication more difficult. In general the 1015 will cold form easier than the 1025, but does not drill or thread as well. For these operations the higher carbon is more desirable.

Machine or carriage bolts which are used extensively in tillage implements are made of low-carbon steel. The development of cold-headed and cold-rolled threads have produced a bolt with high yield strength compared to the forged-head and machine-threaded bolt. The low-carbon steels are use for parts subjected to tensile stresses rather than wear or bending loads, and the merchant bar of commercial quality is usually satisfactory for such parts as gusset plates, tie bars, levers and control rods.

Medium-carbon steels of 0.35 to 0.50 carbon are probably used in the greatest volume in tillage implements. They combine stiffness and strength with only moderate difficulties in welding, punching, machining, and heat-treat easily by a wide variety of methods.

Axles, standards, drawbars and structural members are generally made of C-1045 or 1050. Either of these steels is satisfactory, and it seems to be the result of experience in which one is used. In our company some plants use 1045 and others 1050 for very similar applications. I remember

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several years ago an aviation company's classification of tool and production steels in which 1050 was dubbed "plow steel." In this range the quality of the steel becomes more important. Parts requiring more strength than the low-carbon steels, but not requiring maximum fatigue properties or close hardness tolerances, may be specified of commercial quality. Probably the majority of these steels used in the tillage line are of this quality. Highly stressed heat-treated parts should be specified of fine-grained killed steel.

These steels are considered water hardening but the smaller sections will oil harden to desirable physical properties. In the past, time quenching these steels in brine or water was used in the tillage industry. Now it appears that oil quenching and drawing is becoming more popular because of less distortion in hardening, and elimination of scrap loss because of quenching cracks. For this reason the higher carbon of about 1050 is more desirable.

Welding characteristics change in this range of steel. The 1035 steel welds easily, but welds of 1050 tend to have low ductility and develop crater cracks. The development of the low hydrogen welding rods has helped to overcome these conditions, and with good welding practice satisfactory welds are possible.

Rerolled railroad axles are in the carbon ranges of 0.35 to 0.50 and are available in smal bars and shapes. The principal advantage is slightly lower cost offset by limited availability, and a rather wide carbon range for specific application.

MEDIUM HIGH-CARBON STEELS EXTENSIVELY USED

The medium high carbon steels of 0.60 to 0.70 carbon also find extensive use in the tillage implement line. Plow beams at one time were almost without exception 1071. The manganese extra charge in 1947 increased the price over 1070 so that many manufacturers are now using 1070. 1070 is difficult to drill and some plow beams require a considerable number of holes. There may be a tendency to use a lower carbon steel and better heat-treatment to balance the strength and take advantage of better machineability.

The 1060 steel is used extensively for tool bars on cultivators and planters. These parts require high strength and stiffness. They are generally hot-formed bars and require a minimum of drilled holes. The price of this steel is the same as for 1045 or 1050 but the increased carbon increases the hardness and stiffness, both desirable features in these parts.

High carbon steels of 0.80 to 1.00 percent are the true tillage steels, used for ground working tools — plowshares, moldboards, sweeps, shovels, spring teeth, disks and knives. All of these parts penetrate below the surface of the ground and are subjected to abrasive wear, impact shocks from encountering rocks and stumps, and high tensile and bending loads in dry hard ground. In addition, they must possess a property known as "scouring," that is, the ability to take a smooth polish from the ground so that soil will slide easily over the surface. It is generally considered that of two steels having the same high hardness, the steel with the highest carbon content will resist abrasion and scour better. These steels are generally available only in the highest quality of fine-grained killed steels or electric furnace quality. Each tool produced from these steels has a specific use and its manufacture is governed by processing equipment, cost and desires of the buyer. These tools because of the large replacement business are highly competitive in price. Increased costs of steel and heat-treatment must be justified by increased performance.

Sweeps and shovels are typical of a competitive product produced from a wide range of analysis. Low-carbon sweeps may perform acceptably in loose ground free from abrasive material and can be produced for less cost than a high-carbon sweep. The 1080 steel is an average analysis possessing good strength and wearing properties in the unheat-treated condition, and increased strength and wear when heat-treated.

Disks and coulters are also produced in a wide range of analysis, and in addition two types of rolling, straight rolled and cross rolled. Cross rolling largely eliminates the directional weakness and surface defects of straight rolled steels. Alloy steels are used for the larger sizes of disk plows. This is the largest use of alloy steel in the tillage industry. Before the last war 3160 nickel, chromium steel was used for heavy-duty disks. With the present shortage of nickel, chromium or molybdenum or a combination of the two have been found satisfactory. Technical advances in steel making and heat-treating may eliminate the need for alloy steels for this application.

Harrow disks are generally made of 0.80 to 0.90 carbon steel and heat-treated to approximately spring temper.

SOFT-CENTER STEELS FOR SHARES AND MOLDBOARDS

Plowshares are produced of low-carbon steel carburized, high carbon steel unheat-treated and heat-treated, and soft center steel. The final result of these steels is to produce a hard surface to resist wear. The unheat-treated and heat-treated shares are similar to sweeps and as a competitive product will perform well on a cost basis.

Carburized low-carbon plowshares were omitted from the discussion of low-carbon steels. The producers of carburized shares have developed steel specifications for this application and the properties after carburizing are similar to those obtained with soft-center steel.

The soft-center steels for shares and moldboards have the desirable property of a high-carbon surface and a low-carbon center. This steel is heat-treated to file hardness, but the low-carbon center is ductile and provides necessary strength for the brittle outside surface. The ideal would be a two-ply steel with a hard surface and soft back, but heat-treating strains cause this material to distort to the extent that it is impractical.

The solid shares are produced in carbon ranges of 0.80 to 0.95. An average of this could produce approximately the same hardness and no noticeable difference in wearing characteristics.

The soft-center steels are specified near 1.00 percent carbon for the hard surfaces with the industry tendency to have plowshare steel under 1.00 percent carbon and moldboard steels slightly higher.

The problem of steel simplication for the tillage industry appears to be fairly simple. All of the analysis discussed except soft center steels are used by other industries and for this reason should be available. The qualities and sizes required are more difficult to obtain. Cooperation with suppliers will be helpful in determining qualities and analysis usually available. Recent years have presented constant problems of steel substitution, and this experience has been enlightening, because we have found that it is possible to produce quality products with slightly different analysis than

specified. With this knowledge each organization should be able to simplify its requirements to the most common steels.

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A Tractor Engineer's Viewpoint

W. H. Nordenson

APPLICATION of steels in farm tractors and the design considerations which affect their selection is the purpose of this paper. The production of a tractor from a somewhat limited number of steels has been possible and quite advantageous, and it does not compromise the efficiency or excellency of the product. The statements in this paper are based on my personal experience and do not necessarily reflect that of other tractor engineers and manufacturers.

Since a farm tractor is dependent on the cohesion of its driving tires with the ground surface to develop the pull or push necessary to propel its working tools, weight is of prime importance, and any particular size tractor must have a certain minimum weight to perform its job. Generally in tractor design this means the most weight for the least cost. Such a unique situation is in sharp contrast with implements, harvesting machinery, and pay-load vehicles where the rule is the least weight for the least cost.

The hours of use per year for a farm tractor are long since it provides the power for most of the equipment used on the farm. A log in excess of 800 hr per year is not uncommon especially in areas where the working season is long. Here again is sharp contrast with harvesting equipment and implements where the hours of operation are much less. Such operation establishes the need for low stresses to insure adequate fatigue life.

The aforementioned considerations have much to do in creating what might be called a design philosophy, and have resulted in many cases of designing parts for stiffness rather than strength. The word stiffness is important and is sometimes used loosely to describe a high yield point material. It is used here only in its true meaning of resistance to deflection. Stiffness can be increased only by increasing the moment of inertia of a section. To secure this increase, over-all section dimensions are generally increased. Many advantages accrue from the stiffness approach, particularly where shafts are supported in bearings and gears are supported by shafts. Much time can be wasted making lengthy calculations of bearing and gear-tooth loadings only to have excessive deflections occur under operation which causes misalignment with resultant end loading of bearing rolls or gear teeth. A design based on stiffness, is not usually sensitive to stress raisers and gives satisfactory fatigue life in less costly material.

SOLUTION ELIMINATES TONS OF HEAT-TREATMENT

A rear axle for a row-crop tractor is subjected to large bending loads as well as torque loading when wheels are set in wide-tread position. By designing to a maximum deflection, which gives good performance of the supporting bearings, the diameter is such that a cold-drawn medium-carbon steel of good machineability can be used without heat-treatment. This solution of the problem eliminates tons of heat-treatment, eliminates all straightening operations, provides a low stress design with adequate fatigue life and gives the most weight for the least cost.

To prevent the impression that all problems lend themselves to the above solution, it should be emphasized that many drive shafts are designed with windup sections to minimize peak loadings of gears and related parts. This method is particularly effective when shafts are not subjected to bending and handle pure torque loading. Care must be used to keep the stress range within endurance limits, especially in parts subjected to reversed torsion. Carbon steels can be used rather than alloy steel by proper choice of operating stress range to provide adequate fatigue life. They provide the most weight for the least cost.

Where space limitation is imposed as is usually the case with transmission and final drives, alloy steel is used for gears to provide satisfactory performance at high load levels in the most compact form. However, even in these applications alloy is giving way to carbon steels with induction or flame hardening.

Present practice provides for the fabrication from steel of the many hundreds of parts, exclusive of purchased parts, used in a farm tractor, from 17 chemical analyses of carbon steels and three in alloy. The number of steels used at present is greater than past practice, because the poor availability in certain steels has caused some increase in variety to meet existing conditions.

When it is considered that the total of 20 steel compositions covers sheet, strip bars of various shapes, and numerous forgings, it should be apparent that considerable effort is required to prevent large increases in variety to creep in.

To indicate the relative importance of the form in which steel is used in producing tractor parts, the following information is given: In bar stock, rounds are of great importance, approximately 70 sizes from $\frac{3}{16}$ to $3\frac{5}{8}$-in diameter in ten different chemical analyses of carbon steels and two in alloy, hot rolled and cold drawn. For flats, there are 15 sizes, 6 compositions of carbon steel, hot rolled and cold drawn. Hex is used in 8 sizes, two compositions of carbon steel cold drawn. For squares, there are 4 sizes, 3 types of steel cold drawn and hot rolled. The use of structural shapes such as angles and channels is very small.

SHEET AND STRIP STEELS USED IN LARGE QUANTITY

Sheet and strip is used in large quantity, usually for formed or drawn parts, in 16 gages from 0.024 to 0.1875 in three types of steel. The numerous forgings used account for eight analyses of carbon steel and three of alloy steel.

A look at expected future practice indicates it should be possible to produce the fabricated steel parts of a tractor from 14 types of carbon steel and two of alloy. The composition of these steels would probably be as follows:

CARBON STEEL

1 C 1010 (strip)	6 C 1035	10 C 1050 F
2 0.12 max. C (sheet)	7 C 1041 F	11 C 1113
3 C 1015	8 C 1043 F	12 C 1117
4 C 1019 F	9 C 1045 F	13 C 1137
5 C 1025		14 C 1144

ALLOY STEEL

1 8620	2 5140

With an expected decrease in the number of sizes, an appreciable gain in simplification is achieved. To realize simplification is no easy task, since the problem of minimum number of analyses, fewest sizes and lowest cost is complex. Chemistry extras, quantity extras, availability both at mill and warehouse must be considered and careful compromises made to secure the best over-all result and lowest cost. Then,

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too, if the steel supplier changes the extras on several types of steel, the entire job must be reconsidered.

Since the problem of simplification in steel types is complex, it requires the concerted effort of all parties concerned —the design engineer and plant metallurgist to make skillful application to meet the particular performance and manufacturing requirement and the steel supplier to improve the availability and stability of relative cost of the steels used.

Practically everyone seems to agree that simplification of steel varieties is desirable. How best to achieve it is probably much more debatable, and only intensive effort, time and experience will solve the many problems.

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A Steel Producer's Viewpoint

H. W. Browall

IN MANY years of metallurgical service to farm equipment companies, I have had numerous occasions to recommend steels, some occasion to severely criticize steels specified, and untold requests to explain the need for the apparent infinite number of steels available. Steel products, in addition to size and shape, also require certain mechanical or chemical properties to insure proper functioning of the finished part. The term specification broadly covers amount, size, shape, metallurgical properties, shipment, etc., but in this paper I will consider specification to cover only metallurgical requirements.

Steel products are generally specified to either chemical or mechanical properties which are primarily governed by the finished part end use requirement and secondly by the production and fabrication methods to be employed. It is not acceptable to specify both chemical and mechanical property ranges on a given item because no two producing mills will obtain the same mechanical properties with a given chemical range, nor likewise can two or more producing mills use the same chemical range to arrive at a required set of mechanical properties.

It should be evident at this point that whether specifications are chemical or mechanical the steel producer's basic approach is chemical. Each steel-producing unit has elaborate charts and formulas which indicate for the product, such as bars, plates, structural shapes, sheets, etc., and the particular rolling mill to be used, the range of chemical composition that should be employed to obtain specified mechanical properties.

SPECIFY TO CHEMISTRY OR TO MECHANICAL PROPERTIES

From the above it follows that our first consideration in specifying steel for a given part is whether to specify to chemistry or to mechanical properties. Chemical range specifications are recommended if mechanical properties in the as-rolled condition are of little or no consequence, if the material is to be reheated for forging, if the material is to be heat-treated for enhanced mechanical properties, or if the material requires some special property such as resistance to wear or abrasion either in the as-rolled or heat-treated condition, to mention a few. Mechanical properties should be specified as required when the material is to be used in the final part in the as-rolled condition and mechanical properties are the primary consideration and are attainable as hot rolled.

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There are currently two recognized specification writing organizations, the American Society for Testing Materials and the Society of Automotive Engineers.

The steel specifications of the American Society for Testing Materials are predominantly mechanical property documents, but they do issue some chemical range specifications. For example, specification A-107 covers hot-rolled carbon steel bars to various chemistries and A-306 covers hot-rolled carbon steel bars to various mechanical property ranges.

The steel specifications of the Society of Automotive Engineers are predominantly chemical, the individual chemical ranges being identified by a coded numbering system. A third organization, the American Iron and Steel Institute, also issues a coded and numbered series of chemical range compositions. The Society of Automotive Engineers' list of carbon steels consists of 66 steels used by two or more automotive manufacturers in significant quantities. The American Iron and Steel Institute list of carbon steels consists of 98 steels produced by the member steel companies for all customers in significant tonnages, however, being applicable only to bars, wire rod, and semifinished for forging. Provision is made in the Society of Automotive Engineers' lists so that they can be applied to practically all steel products. It should be noted here that through cooperation between the technical committees of the Society of Automotive Engineers and of the American Iron and Steel Institute any code number appearing in both lists has an identical chemical composition. In other words, and contrary to vehemently expressed opinions, an SAE 1045 and an AISI 1045 are chemically interchangeable.

At this point the question always arises concerning the total number of steels on either the SAE or AISI list of chemical composition. About fifteen years ago the SAE list of carbon steels consisted of 35 compositions, whereas today there are 66 compositions. Again, fifteen years ago the AISI original list of carbon steels had 106 compositions, whereas today there are 98 compositions. Periodic surveys by the consuming members of the SAE and by the producing members of the AISI invariably disclose candidates for recognition and candidates for deletion. A candidate for recognition is reviewed thoroughly and must be justified by its sponsors, quantity requirement, and general usage before such recognition is granted by either body. Candidates for deletion must indicate decreasing usage or non-usage in two or more successive surveys before they are deleted and then only after concurrence in the move by users and producers. It is the definite attitude within both the SAE and the AISI that there are too many chemical compositions on both lists and the trend is toward fewer and not more steels. At the moment, and resulting from a recently completed survey of producing mills, there has been one steel nominated for addition and 25 steels recommended for deletion from the AISI lists. Thirteen of the steels up for deletion are also on the SAE lists and will be acted upon by that organization in the near future. Emergency economic conditions in recent years has been more hindrance than help in this program.

QUALITY OF STEEL AN IMPORTANT CONSIDERATION

Having determined whether as-rolled mechanical properties or chemical properties are required, the next consideration is quality. It is possible to meet chemical or mechanical properties but still have a steel which will not fabricate satisfactorily. The concept that all steels are the same, except for

chemical or mechanical properties, is false and misleading. It is a fact that carbon steels are produced within the specified chemical limits of a given grade but still may have widely dissimilar characteristics. In steel production various practices employed determine the type, characteristics and quality of the finished product and each has its proper and useful place, governed by the end product to be made and the methods of fabrication to be employed. It would be wasteful to make all steels of a high quality regardless of end use and for many applications nothing would be gained in the performance of the part. Conversely many applications do require high quality standards and specification of such is necessary and justifiable.

Technically, steel quality is indicative of many conditions, such as the degree of internal soundness, relative uniformity of chemical composition or mechanical properties, relative freedom from injurious surface imperfections, ability to fabricate satisfactorily by the methods to be used, suitability for the specific end use, etc.

For all products each has one or more fundamental qualities with additional requirements for particular applications available. Unfortunately in each product the various qualities are not, with few exceptions, recognizable by the same nomenclature. For instance, the basic quality in hot-rolled carbon steel bars is "merchant quality"; in hot-rolled carbon steel plates, "regular quality"; in cold finished carbon steel bars, "standard quality"; in hot-rolled and cold-rolled carbon steel sheets, "commercial quality"—to mention a few. A fairly comprehensive list is published in the SAE handbook. This list is not complete, but refers to the applicable AISI product manuals for further and complete details for a given product.

Space does not permit detailing of the many qualities and variations thereof in this paper. A hurried look at hot-rolled carbon steel bar qualities may be of interest and will indicate the pattern for all products.

Merchant quality hot-rolled carbon steel bars are applicable to a wide range of uses, such as structural and similar miscellaneous applications, involving mild cold bending, mild hot forming, punching and welding as used in the production of non-critical parts of bridges, buildings, ships, agricultural implements, road machinery, railway equipment, etc. Specification of the type of steel (rimmed, capped, semikilled, or killed), silicon content or grain size control are not acceptable in this quality. These bars should be free of visible pipe but they may contain pronounced chemical segregation and for this reason check analysis limitations are not recognized unless mixed steel is clearly evident. Seams and other surface imperfections may be present and are to be expected in this quality.

QUALITIES OF HOT-ROLLED CARBON STEEL BARS

Special quality hot-rolled carbon steel bars are produced for applications involving forging, heat-treating, cold drawing, machining, severe forming, etc. The type of steel (rimmed, capped, semikilled, or killed) may be specified dependent upon chemical composition, producer's facilities, and the customer's method of fabrication and end use. Grain-size control if required may be specified in killed steels only. Silicon limits compatible with the other chemical elements involved may also be specified. The specified chemical limits in this quality are subject to published variations in check analysis. In the production of this quality visible pipe is removed and the blooms or billets are conditioned to minimize injurious surface imperfections.

These are the fundamental qualities of hot-rolled carbon steel bars. Additional requirements may be imposed on special quality which will be named but not defined. Most prominent of these are cold heading, special surface, heat-treating results, decarburization testing, macroetch testing, fracture testing, non-metallic inclusion testing, extensometer testing, and impact testing.

It should be noted at this point that the foregoing rules are applicable generally to all steel products. There are exceptions, however, notably sheets and strip, and wire rod and wire. These products are obtainable to chemical composition or mechanical properties when either is the primary requirement but relatively small percentages are so specified.

In the production and use of these materials end use and method of fabrication by the consumer are the primary consideration. This results in these steels being specified with no reference to chemical composition or mechanical properties but by requiring the steel producer to furnish steel to make an identified part on the equipment and by the fabricating methods available to the consumer. The testing of sheet steel and the evaluation of test results has not yet been developed to a point where the drawability of a lift of sheets can be predicted with a high degree of accuracy. Consequently the surer means of defining the specifications currently seems to be in terms of expected performance in the fabrication of an identified item.

Finally there is another method of specification termed by us as "proprietary." This is usually a specification written by a consumer to cover added special requirements or to cover a steel which has no counterpart in SAE, ASTM, AISI specifications. Many such specifications are merely copies of existing SAE, ASTM, or AISI documents and while accepted are considered by us as wasteful and unnecessary. The proprietary specification when warranted is an acceptable method of specifying steel for numerous specific end uses. This specification resolves itself into a statement to the steel producer from the consumer concerning his desires; however, such a specification does not always represent the consumer's actual needs. His needs may be more or less than those presented in the specification.

PROVISIONS FOR PROPRIETARY SPECIFICATION

The proprietary specification should cover scope, method of steel manufacture, chemical composition or mechanical properties, tolerances, methods of testing, and number and selection of samples for testing. In addition it may also cover packaging, marking and loading requirements. All provisions of such specifications should be consistent with recognized practices and procedures. In the above provisions, the most important is the scope clause which must clearly state the end use or uses of the steel being specified. An inadequate scope clause means a troublesome or poor specification. A strong scope clause can save an otherwise poor specification, for it puts performance responsibility on the steel producer if he accepts the document as presented.

There are other phases of this project and many many more details of all phases but, in the interest of brevity, I would like to be permitted to close with these thoughts:

Be as meticulous in the selection of the steel for an end use as you are in design. *(Continued on page 708)*

Soil Mixing Characteristics of Tillage Implements

W. C. Hulburt and R. G. Menzel
MEMBER ASAE

EVALUATION of applications of soil conditioners to soils is facilitated by a knowledge of the thoroughness of mixing the conditioner with the soil. Little information is available as to the soil-mixing characteristics of various tillage implements, although their tilth-creating characteristics are well known. Therefore, two experiments were carried out to study the mixing (with the soil) of a traceable material which originally had been spread uniformly on the surface. In the first experiment, a series of tillage operations was carried out with radioactive phosphate solution as the tracer material. In the second experiment, primary tillage operations were studied with granules of about 1/10 in diameter as the tracer material.

In the first experiment, a series of shallow and deep-tillage operations were conducted. Shallow-tillage operations were carried out with a rotary tiller, spike-tooth harrow, corrugated rollers, or mulcher set to till one inch of soil. Deep-tillage operations were carried out with a rotary tiller, disk harrow, or spring-tooth harrow set to till 6 in of soil. Since the rotary tiller was the only implement which mixed the soil uniformly to a 6 in depth, the second experiment which was carried out two months later included tillage operations with 6 in and 16 in moldboard plows. Instead of radioactive phosphate, granules of uniform size were spread on the surface of the soil before tillage or at the time tillage implements were in operation.

EXPERIMENT WITH RADIOACTIVE PHOSPHORUS

Treatment of Plots. Radioactive phosphorus was used to measure the efficiency of various tillage operations in mixing a chemical with Elkton silt loam soil at Beltsville, Md. A level field 200 by 300 ft was plowed 7 in deep and worked down to a compact, finely prepared seedbed by disking and harrowing. The field was divided lengthwise, shallow tillage operations to be carried out on one-half and deep-tillage operations on the other. Just prior to spraying the radioactive phosphate solution, the plot areas were wet down gently to reduce the danger of radioactive dust contaminating the air.

Irradiated potassium dihydrogen phosphate containing P^{32} obtained from Oak Ridge National Laboratory of the Atomic Energy Commission was dissolved in water. The solution was sprayed on the surface of the soil with a tractor spray rig at estimated rates of 16 microcuries per square foot for the shallow tillage treatments and 100 microcuries per square foot for the deep treatments. Each sprayed area consisted of four strips, 6 ft wide, running lengthwise on each half of the field. Each strip was separated by an alleyway approximately 5 ft wide. A wide turning area was left between the two sprayed areas and on each side.

The tillage operations were carried out immediately after spraying on August 26 and 27, 1952. In the shallow tillage experiment, two of the four strips of treated soil were spike-tooth harrowed once. Then eleven shallow-tillage operations were carried out across all four sprayed strips, giving a total of twenty-two treatments. In the deep tillage experiment, two of the four strips of treated soil were disk-harrowed once. Then seven deep-tillage operations were carried out across all four sprayed strips, giving fourteen treatments. All tillage operations extended at least 6 ft beyond the outer edges of the sprayed strips. The treatments in both experiments were replicated four times in randomized blocks. Each replicated plot contained four subplots, two with and two without cross tillage.

The following field equipment was used to conduct the radioactive soil-mixing study:

- Tractor spray rig with two 6-ft booms, equipped with two sheet plastic shields to restrict the mist drift of the radioactive solution
- Mobile 500-gal water tank and compressor with two high-pressure wands (for preliminary wetting of plot area)
- Three-plow tractor with wheels set on 6-ft centers
- Tripod implement hitch
- Tandem, disk harrow, 6-ft
- Spring-tooth harrow, 6-ft
- Rotary tiller — solid curved blade, power-take-off-driven — effective width, 51 in
- Small corrugated roller (double), rings 1¼ in deep, 2 in on centers; effective width, 5 ft, 4 in
- Large corrugated roller (double), rings 2 in deep, 4 in on centers; effective width, 7 ft
- Mulcher (same as above roller, but one set of spring-tooth-harrow teeth between two rollers), 7 ft.

Measurement of Samples. The efficiency of mixing was evaluated by determining the distribution of P^{32} in six sample cores taken from each subplot. In deep tillage the cores were of 2-in diameter and 6 in deep, and were divided at 2 and 4-in depths to give three samples per core. In shallow tillage the cores were the same diameter, but only 2 in deep, and were divided at one inch to give two samples per core. Each sample was dried, crushed, and thoroughly mixed.

Relative amounts of P^{32} in the samples were determined with an end window Geiger-Muller tube. The sample was placed in a 250-ml beaker and raised until the sample surface was ½ cm below the end window. Since all samples were of greater than infinite thickness, the count obtained was proportional to the activity of P^{32} in each sample. As

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The authors—W. C. HULBURT and R. G. MENZEL—are, respectively, associate agricultural engineer in the division of farm machinery and soil scientist in the division of basic soil and plant relationships (BPISAE), U.S. Department of Agriculture.

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TABLE 1 AVERAGE COUNTS OF P^{32} PER SAMPLE TAKEN FROM DIFFERENT DEPTHS AND AFTER DIFFERENT TILLAGE OPERATIONS (Standard = 400)

Tillage operation	Depth in inches 0-2	2-4	4-6	0-6
Rotary tiller 3 times	118	124	133	375
Rotary 2 times	164	172	150	486
Rotary 1 time	226	169	48	443
Rotary 1 time cross-disked	184	162	86	432
Spring tooth harrow	257	60	0	317
Spring tooth cross-disked	216	65	0	281
Disk 1 time	258	73	0	331
Disk 1 time cross-disked	223	68	1	292
Disk 2 times	224	102	1	327
Disk 2 times cross-disked	243	129	11	383

LSD (0.05) = 52

the time required for counting all the samples was three weeks, one sample was selected from the first ones counted, and carried as a standard through all the determinations. The counts for all samples were corrected to a counting date of September 21.

It was impossible to make P^{32} determinations on samples from all the treatments and replicates before the radioactivity had decayed to a level too low for practical measurement. The most significant treatments were given priority in measurement and only two replicates of each treatment could be measured.

Results. Vertical mixing is indicated by average counts on samples from different depths (Table 1) and by coefficients of variation between depths of sampling (Table 2). Two passages with the rotary tiller were required to mix P^{32} uniformly to a depth of 6 in. The spring-tooth harrow and disk did not mix thoroughly, even to a depth of 4 in. The lack of agreement among total counts found in sample cores from different treatments may indicate non-uniformity of spraying of phosphorus, but does not invalidate the conclusions on mixing efficiency of the implements.

Horizontal mixing is indicated by the coefficients of variation between the counts on the six sample cores taken from each subplot (Table 2). Because some subplots had no P^{32} at the 2-4 and 4-6 in depths, coefficients of variation were extremely variable and no significant differences were found at those depths. However, the data at the 0-2 and 0-6 in depths show that the tandem disk gives poorer horizontal mixing than the rotary tiller or spring-tooth harrow.

TABLE 2 COEFFICIENTS OF VARIATION BETWEEN SAMPLE CORES IN EACH SUBPLOT AND BETWEEN DEPTHS OF SAMPLING

Tillage operation	Coefficient of variation Between sample cores 0-2 in	2-4 in	4-6 in	0-6 in	Between depth
Rotary 3 times	34	41	35	31	8
Rotary 2 times	22	35	37	25	18
Rotary 1 time	46	56	76	32	66
Rotary 1 time cross-disked	36	59	54	36	41
Spring tooth harrow	29	121	(a)	36	129
Spring tooth cross-disked	46	94	(a)	44	122
Disk 1 time	73	163(b)	(a)	88	131
Disk 1 time cross-disked	73	137	243(c)	74	125
Disk 2 times	76	108	243(c)	70	109
Disk 2 times cross-disked	56	69	6(c)	37	94
LSD (0.05)	21	80	n.s.	27	33

(a) These samples contained no P^{32}.
(b) One subplot of four contained no P^{32}.
(c) Only one subplot of four contained any P^{32}.

TABLE 3 AVERAGE COUNTS OF P^{32} PER SAMPLE AND COEFFICIENTS OF VARIATION BETWEEN SAMPLE CORES AFTER DIFFERENT TILLAGE OPERATIONS

Tillage operation	Counts from P^{32} in 0-1 in layer	1-2 in layer	Coefficient of variation between sample cores in 0-1 in layer
Corrugated roller once	101	0	45
Corrugated roller 2x	84	0	106
Corrugated roller 3x	119	0	56
Mulcher once	82	0	67
Mulcher 2x	56	0	64
Rotary tiller once	110	0	44
Rotary tiller 2x	103	11	38
Spike tooth harrow once	144	0	69
Spike tooth harrow 1x crossed	112	0	79
Spike tooth harrow 2x	106	0	46
Spike tooth harrow 3x	99	0	52

None of the shallow treatments caused any significant variation in relative amounts of P^{32} in the sample or in coefficients of variation between sample cores (Table 3). No implement except the rotary tiller mixed P^{32} below the top inch of soil. It was noticed that small samples tended to give higher counts than full-sized ones, which was an indication that mixing was mostly with the top fraction of an inch of soil. However, observations with a radiation survey meter in the field indicated that 95 percent of the P^{32} was covered with at least ¼ in of soil.

SOIL MIXING EXPERIMENT MEASURING EFFICIENCY OF PRIMARY TILLAGE OPERATIONS BY GRANULES

This second study differs from the radioactive phosphate experiment in several ways. As indicated before, the principal object of this second experiment was to use primary tillage operations as a means of securing greater penetration of conditioners into the soil. Therefore, it was felt tracer material should be added in the process of plowing and preparing the seedbed, rather than after the soil had been put in the form of a prepared seedbed. In addition, sorghum grain was used as a tracer material to measure the mixing abilities of different treatments. Interest in a new technique as well as lack of time to secure another shipment of radioactive phosphate before winter weather arrived necessitated the change. Some eight or more different kinds of granules were studied and tested as to their ability to measure soil mixing. A sorghum grain was found superior in giving good representation of soil-mixing action as well as having one of the highest accuracies in locating or recovering the granules in the soil.

Treatment of Plots. A clean, fallowed field of Sassafras loamy sand at Beltsville, Md., was selected for the experiment. The field was not worked before processing the treatments or broadcasting the granules. Except when otherwise stated, the granules were broadcast with a gravity flow spreader which had an effective width of 3 ft. Strips 100 ft long were spread in the path of the tillage operation.

Ten tillage operations were carried out on November 12 on plots 6 ft wide by 100 ft long. Six operations involved the moldboard plows and the other four operations were similar to four deep-tillage operations in the experiment with radioactive phosphorus, except that they were not carried out on a prepared seedbed. Two cross operations were added to the ten base treatments. The cross operations were disk harrowing and spring-tooth harrowing. Thus, the plot layout resulted in each strip having four areas cross disked, four areas cross spring-tooth harrowed and four no cross-operation areas. Individual plot areas had the size of 3 by 5 ft. The base treatments are the following:

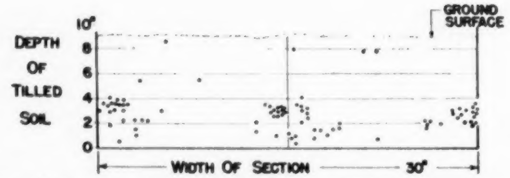

Fig. 1 (pattern 1) Dispersal of pellets in the soil by broadcast on surface followed by plowing 7 in deep with a 16-in moldboard plow and cross spring-tooth harrowing 4 in deep

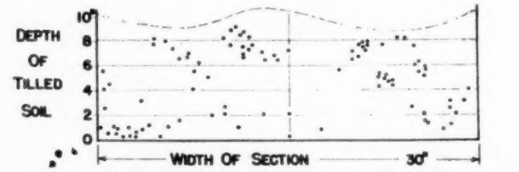

Fig. 2 (pattern 2) Dispersal of pellets in the soil by application at jointer and furrow crest when plowing with 16-in moldboard plow, 7 in deep

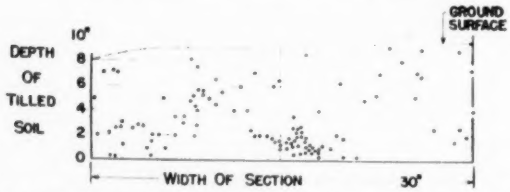

Fig. 3 (pattern 3) Dispersal of pellets in the soil with half broadcast before 3-in disking and 7-in plowing, second half broadcast before 3-in disking and 4-in cross spring-toothing

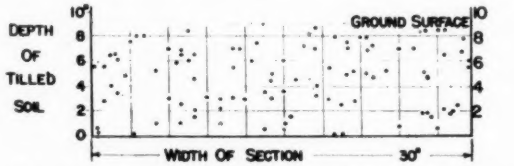

Fig. 4 (pattern 4) Dispersal of pellets in the soil by broadcast on surface and rotary tilling twice 6 in deep

1 One-half granules broadcast, disk, plowed 6 in deep. Remaining half of granules broadcast, disk.

2 Plow (16 in moldboard) and apply granules through fertilizer hopper in two streams — one on jointer; one on furrow as it leaves the moldboard.

3 Plow (16 in moldboard) and apply granules through fertilizer hopper in two streams on the furrow wall of the plowed land.

4 Plow (16 in moldboard).

5 Disk harrow; plow (16 in).

6 Plow (6 in moldboard).

7 Disk harrow 2-3 in deep.

8 Spring-tooth harrow 3-4 in deep.

9 Rotary tilled once.

10 Rotary tilled twice.

Treatment Plotting Procedure. The soil had fair moisture content at the time of tillage operations. A number of cross-section plottings were made the first two days, which included one plot each base treatment and one of the cross-disked treatments. About ⅔ in of rain fell over the weekend, which settled the fluffed soil about one inch. (It should be noted at this point that this comparatively light soil bulked considerably, in that plowing 6 to 7 in deep left a vertical depth of tilled soil of some 10 to 11 in. The accompanying diagrams bear out this point as the ground lines are measured from the plow sole line.) Plotting after the rain was much easier and better in that a vertical plane could be cut cleanly without sloughing off of the top 3 or 4 in of soil. The cross sections were dug carefully to the bottom of the tilled soil and were about 3 ft long and one foot wide. A 30-in straight edge was placed on the bottom of the section, and a sheet-metal edge attached to the straight edge was forced into the base of the vertical section one-half inch. A line scribed on the metal edge gaged this one-half inch insertion and served as a depth or breadth measure of the soil to be dug away in locating the granules. A gage line at the top of the section was made by a string between two small stakes. As each granule was unearthed, a vertical measurement was made from the straight edge giving both a vertical and horizontal measurement. A recorder plotted each granule location on a scaled diagram as the measurements were made.

Of the 120 plots put in the field, some 32 were cross-sectioned and plotted before winter weather stopped field operations. Although the sampling was not large enough to give complete results on the (Continued on page 706)

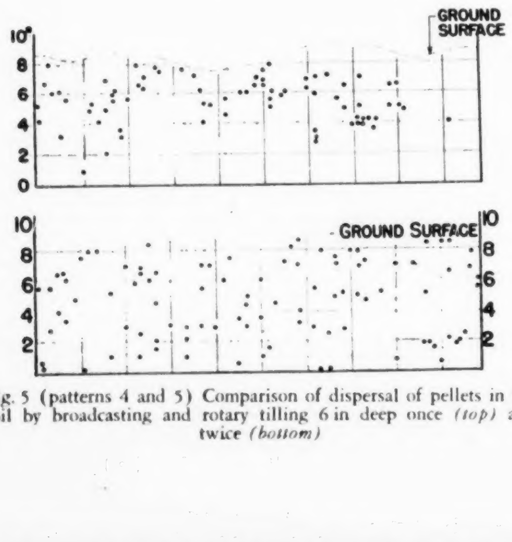

Fig. 5 (patterns 4 and 5) Comparison of dispersal of pellets in the soil by broadcasting and rotary tilling 6 in deep once *(top)* and twice *(bottom)*

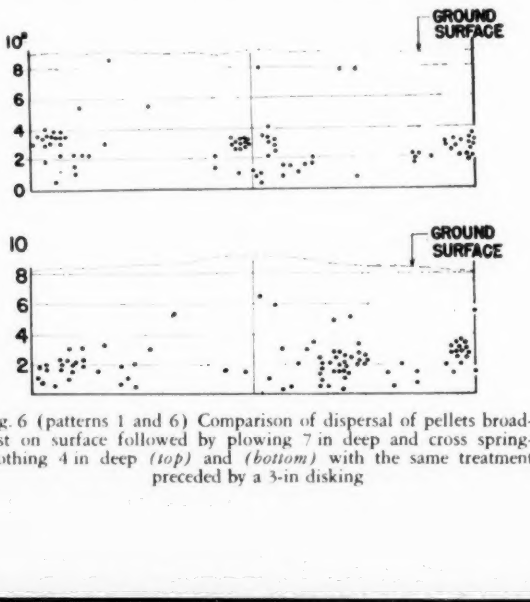

Fig. 6 (patterns 1 and 6) Comparison of dispersal of pellets broadcast on surface followed by plowing 7 in deep and cross spring-toothing 4 in deep *(top)* and *(bottom)* with the same treatment preceded by a 3-in disking


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Soil Mixing Implements

(Continued from page 704)

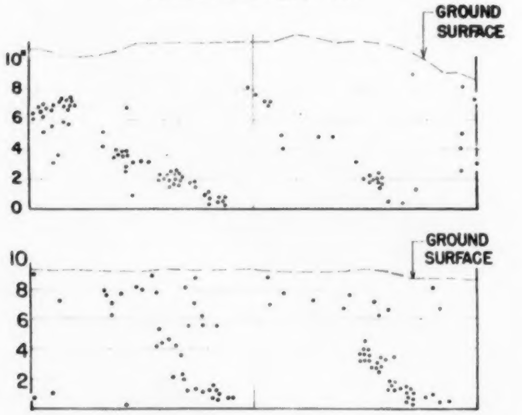

Fig. 7 (patterns 7 and 8) Comparison of dispersal of pellets applied on plowed furrow wall, plowing with a 16-in moldboard plow *(top)* and same treatment plus 4-in cross spring-toothing *(bottom)*

thirty treatments, comparison of diagrams, which were felt typical of the treatments they represent, did give some definite indications of their respective merits. The accompanying cross-sectional patterns (Figs. 1 to 9) of some eleven treatments are shown and discussed with the above limitations:

Diagram of Mixing Patterns. The first pattern (Fig. 1) shows the dispersal of broadcast sorghum grain by plowing with a common moldboard plow. Most of the granules are in the lower part of the tilled zone, and even though this plot had a cross operation of spring tooth, little dispersal was effected by this single operation. The next three diagrams show some of the better mixing operations. The second pattern (Fig. 2) is that of applying the granules as the soil is being tilled with a 16 in moldboard plow. A fertilizer hopper (on the plow) is used to dispense the pellets at a uniform rate, and one stream was directed on the jointer and the other on the furrow slice as it leaves the moldboard. The third pattern (Fig. 3) is one of about the same degree of mixing as the second pattern, but the method involves broadcasting half of the pellets on the surface, followed by disk harrowing and then plowing. The remainder of the pellets were then broadcast, and the soil disk harrowed and cross spring-tooth harrowed.

The fourth pattern (Fig. 4) is the mixing of granules broadcast on the surface and rotary tilled twice to a depth of 6 to 7 in. This diagram shows the best uniformity of dispersal in this series.

The remaining seven patterns show some of the poorer mixing operations. Patterns 5, 6, 7, 8 and 9 show the poorer mixes and patterns 10 and 11 (Fig. 9) show mixing of disk and spring-tooth harrows on unplowed land.

Fig. 5 (patterns 4 and 5) shows the comparative mixing pattern of rotary tilling once versus rotary tilling twice. The shallow mixing of once over with this implement corroborates the findings in the radioactive phosphate study.

Fig. 6 (patterns 1 and 6) shows the comparative mixing of plowing alone versus disk harrowing before plowing. Dispersal of the material is better in the latter operation, but the action is confined mainly to the lower half of the tilled zone.

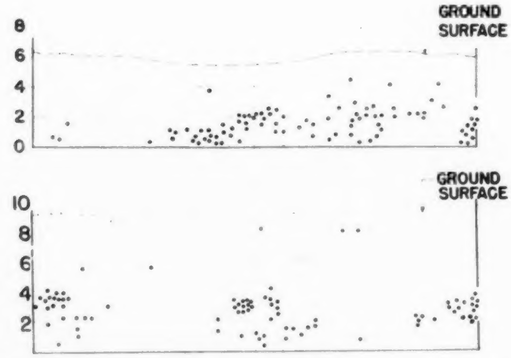

Fig. 8 (patterns 9 and 1) Dispersal of pellets in the soil after broadcast on the surface and *(top)* plowed 5 in deep with 6-in moldboard plow followed by cross spring-toothing 3-in deep, compared with *(bottom)* plowed 7 in deep with 16-in moldboard plow followed by cross spring-toothing 4 in deep

Fig. 7 (patterns 7 and 8) shows two conditions when applying the granules on the furrow wall of the plowed land as the soil is being plowed. The two views contrast the effect of cross spring-tooth harrowing. Fair dispersal is attained with this second operation, but the action is confined to the upper part of the tilled area. It appears a field cultivator operating full depth of the tilled soil could give a good mix in both top and bottom of the tilled soil.

Fig. 8 (patterns 9 and 1) compares the mixing patterns of a 6-in moldboard plow with a 16 in plow. Both patterns are similar in that most of the material is in the lower part of the tilled soil. However, the small plow has smaller intervals or gaps between groups of granules. Operation of the small plow was not as positive as the 16 in moldboard plow and therefore had greater irregularity. The concept of having a series of vertical lines of applied materials in contact with the soil after plowing, and then dispersing this through the soil with a spring-tooth harrow did not bear out in these trials.

Fig. 9 (patterns 10 and 11). In these two diagrams, the mixing characteristics of disk harrow and spring-tooth harrow on unplowed land are compared. The spring-tooth operation appears to give a better distribution of the granules. Both treatments were cross spring-tooth harrowed. Although the pattern appears good for spring-tooth harrowing, the total soil depth of this mixing (of compact soil) is around 3 to 4 in. *(Continued on page 708)*

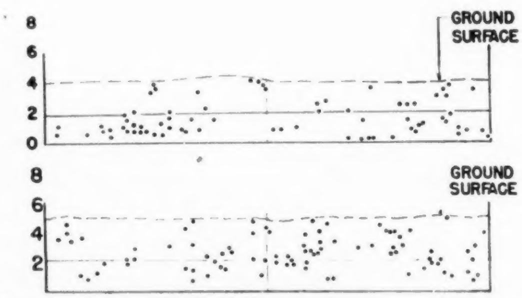

Fig. 9 (patterns 10 and 11) Comparison of dispersal of broadcast pellets by disking 2 to 3 in deep followed by cross spring-toothing 3 in deep *(top)* and spring-toothing 3 in deep followed by cross spring-toothing 3 to 4-in deep *(bottom)*

Soil Mixing Implements

(Continued from page 706)

IN CONCLUSION

Broadcasting half the grains before and half after plowing, or applying them through a fertilizer hopper at the time of plowing resulted in fair vertical distribution, but not too good horizontal distribution of grains, particularly in comparison with rotary tilling. Plowing under grains broadcast on the surface placed most of the grains near the bottom of the tilled section. Crossing with the spring-tooth harrow improved the horizontal distribution in the upper half of the section, but the tillage was not deep enough to affect distribution in the lower half. Disking and spring-tooth harrowing with a spring-tooth crossing gave fairly uniform distribution of grains to a depth of 3 or 4 in. Rotary tilling gave very uniform distribution of grains, but had to be repeated for this to be effective to the full depth of the tilled section. The observations made by this method were in agreement with those made on similar treatments by the radioactive phosphorus method.

DISCUSSION

It is generally recommended that the effective application of soil conditioners requires they be mixed thoroughly with the desired depth of soil. Two or three operations of a rotary tiller gave the most uniform distribution of tracer materials through the soil. Whether or not the finely pulverized soil left after rotary tilling should be stabilized with a soil conditioner has not been determined. It appears that a combination of plowing and deep spring-tooth harrowing (as with field cultivators) might achieve nearly as uniform distribution, and still retain some of the natural structure of the soil.

The methods used to measure soil mixing gave consistent results. Both methods are laborious. The radioactive phosphorus measurements required one to two man-days per treatment. The cross-sectional plottings required about ¾ man-day per treatment. However, much time was consumed in crushing the silt loam samples, which hardened in process of drying before radioactive phosphorus measurements were made. A numerical index of mixing is obtained with the radioactive phosphorus measurement, and it may be that a more representative sampling of the plots is obtained from six core samples than from one cross section.

SUMMARY

Radioactive phosphorus and sorghum grains were used to study the mixing of soil by various tillage operations. All shallow-tillage operations tested mixed the tracer material with the surface soil to a depth of less than one inch. Deep tillage operations varied enormously in uniformity of mixing tracer material with the surface 6 in of soil. Two operations with a rotary tiller were necessary to mix the soil uniformly to a 6 in depth. The spring-tooth harrow and disk harrow did not mix the tracer materials with the lower part of the tilled section. The disk harrow left a nonuniform horizontal distribution of the tracer materials. Plowing left most of the tracer material in the lower part of the tilled section. This irregular mixing could be avoided to a certain extent by (1) applying half the material before disking and plowing and the remainder before final harrowing, or (2) applying the material through a fertilizer hopper at the time of plowing. The soil cross-section patterns indicated the use of a deep spring-tooth harrow such as a field cultivator could give fairly good soil mixing in both top and bottom zones of a plow furrow slice, if used in conjunction with plowing operations.

Ventilating Rates for Poultry Houses

(Continued from page 692)

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Hydraulic-Type Dynamometer

(Continued from page 694)

Their results show that the zero position will shift in the order of 4 percent for a 50 F temperature change. They reduced this zero shift error to about 0.2 percent for a 50 F temperature change by using a regulated pressure and a restrictor connected in series in the oil line between the pump discharge and the hydraulic piston-cylinder assembly. The reason for this improvement is attributed to the restrictor which supplies a greater flow rate as viscosity is reduced and thereby maintains a constant piston-cylinder equilibrium reaction at any given load.

It is believed the hydraulic dynamometer and scale unit will adequately fulfill the needs of laboratory instruction for which it was designed. The combined unit has been found to be very sensitive to any changes in speed and load. Its simplicity of operation makes it a desirable piece of equipment for classroom and research work.

Farm Implement Steels

(Continued from page 701)

Insofar as possible, select steels publicized by recognized specification organizations. If chemistry is required, design so as to use a standard grade of chemical composition. If mechanical properties are required, design to use a standard range. By all means design to avoid minor differences in chemistry or mechanical properties as this can be a nuisance economically and from a procurement standpoint. Your steel producer stands ready at all times to consult with you and advise you regarding available steels, their limitations and their beneficial points.

Remember your own procurement and warehousing problems as well as fabrication problems and attempt to standardize on as few popular steels as possible – the fewer the better.

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+

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RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

USDA Research Activities

Insect Pest and Plant Disease Control Machinery. Studies have continued during the past year of insect pest and plant disease control machinery by BPISAE's Division of Farm Machinery, in cooperation with the Bureau of Entomology and Plant Quarantine, and with the Ohio Agricultural Experiment Station at Wooster, Ohio. The studies have covered air fluidization of dry pulverized materials, the effects of pesticides on application equipment, of application rates, pressures and nozzle types of sprayers in corn borer control, low-gallonage air-blast spray equipment for truck-crop disease control, and improved techniques to facilitate measurement of spray-nozzle patterns in terms of size and distribution of drops produced.

Air-fluidization studies were directed toward determining the adaptability of the principle and its practical value for measuring, conveying and distributing dry bulk material from agricultural aircraft. A machine capable of meeting these requirements and also large enough to use on agricultural aircraft was developed and proved efficient after the development and trial of a pilot model. It was found, however, that further study is needed to solve the special problems in connection with accurate control of low air pressures through regulators and other spray-machine controls.

Experiments on the corrosive and abrasive effect of insecticides on application machinery showed the spray tank to be the most seriously damaged, with the hose, pump and nozzle components next in order. Many types of protective coatings used by manufacturers have been found largely unsatisfactory and so far none has been found which meets the requirements. Reduced damage, however, results from the use of the newer types of synthetic rubber compounds for hoses and gaskets. Dusters are usually affected less by corrosion than sprayers, unless there is moisture present. Damage to dust-application equipment may be considerable, however, if the more abrasive dilutents are used in the dust insecticides.

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Pink Bollworm Exterminator. V. E. Stedronsky, USDA agricultural engineer of Mesilla Park, N. M., and C. B. Ray, Bureau of Entomology and Plant Quarantine, USDA, of El Paso, Texas, have applied for a public patent on a device that literally beats pink bollworms to death. Together they have invented a device for this purpose which has proved itself worthwhile in test runs.

The machine, designed to exterminate pink bollworms in cotton gin trash, does this work as the trash is being blown to the refuse pile. The exterminator unit is installed in the regular trash line of the gin and is fitted with rotary beaters designed to strike every particle of trash from one to three blows with sufficient force to kill all of the bollworms in it.

The beaters, which resemble threshing-machine cylinders, turn at 4,000 rpm and rotate against the flow of trash which moves into the beaters at about 4000 fpm in the pneumatic system. This action thoroughly beats the trash and kills the worms so they cannot spread and start infestations elsewhere. The beaters are of the type used in opening and cleaning machinery in cotton mills, but the device and the method in which these beaters are employed present a new idea.

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Time-Temperature Controller. John G. Taylor, USDA agricultural engineer, Lafayette, Ind., has made application for a public patent on a proportional-time-temperature controller for use with infrared lamps employed to provide radiant energy for the brooding of baby chicks.

The device is designed to vary with respect to temperature, the proportion of time "on" to time "off" of the infrared lamps, which provides closer control than is possible with other controllers in such brooding equipment. The device employs a motor-driven cam which by means of a cam follower attached to a switch transmits a reciprocating motion to the switch in relation to the thermostat-sensing-element plunger. Switching action is accomplished when the switch and plunger are brought together by their respective forces. The device can be adjusted to provide its proportional action over different temperature ranges. In addition, the timing cycle may be controlled by varying the cam speed and the cam may be cut out for linear or non-linear proportional action.

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Stick Removal for Cotton Gin. Gerald F. Franks, USDA agricultural engineer, Stoneville, Miss., has invented a device for the removal of sticks which make up a large part of the trash in machine-stripped cotton. He has applied for a public patent on the device which can be constructed largely of readily available stndard cotton gin parts.

The machine, made up of a vertical series of cleaning units, makes use of centrifugal force to bring the sticks into contact with bars spaced at right angles to the plane of the gin saws. Brushes revolving in the same direction as the saws, but at a faster rate, remove the cotton from the saw teeth as the sticks are thrown into or caught by the bars and carried off in the trash line. Tests of a pilot model having five cleaning units in tandem show that an excellent job of stick removal can be done.

Success of the test runs, made at the Chickasha Cotton Research Station, has resulted in the making of every effort to construct a full-sized model for testing during the 1953-54 ginning season.

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Moisture Restoration for Cotton. Charles S. Speakes, USDA agricultural engineer, and Anselm Clyde Griffin, of the Cotton Branch, P&M, USDA, both of Stoneville, Miss., have collaborated on a method of restoring moisture to seed cotton in multiple stages during ginning and have applied for a public patent on the process. The method makes use of combinations of humid air, wetting agents, steam or refrigeration so as to properly condition seed cotton to about 5 percent moisture content for good cleaning, about 7½ percent for best ginning, and up to about 10 percent for good baling. Use of the method also makes it possible to achieve the moisture restoration at a rate of keeping with normal ginning speeds.

A device that will make use of this new moisture-restoration method has been invented by Edsel A. Harrell, USDA agricultural engineer, also at Stoneville, who is seeking a public patent. This device moistens the seed cotton by a spray as it passes through a moistening zone, traps spray not picked up by the cotton and evaporates surplus moisture at points where the cotton might otherwise adhere to the gin and cause trouble. The machine is capable of applying moisture at the usual rate of ginning and employs in limited quantities, chemical wetting agents found suitable by the USDA Ginning Laboratory.

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Arthur W. Cooper has joined the USDA agricultural engineering staff as assistant to M. L. Nichols, director of the USDA Tillage Machine Laboratory at Auburn, Ala. He transferred recently from the soils group, having been with the USDA since December, 1949. He is a native of Alabama, obtaining his master's degree in agricultural engineering at Alabama Polytechnic Institute where he served as assistant professor from 1941 to July, 1945. Following this he spent about 10 months in the U. S. Navy and in 1946 joined the agricultural engineering teaching staff at Purdue University where he continued until December, 1949.

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Glenn A. Cumings, USDA agricultural engineer, has been appointed to the council of the American Association for the Advancement of Science as the official representative of the ASAE. As a member of the AAAS council, he will participate in annual business meetings of the Association, take part in council debate on programs and publications and in the election of officers.

INSTRUMENT NEWS

KARL NORRIS, Editor

Sponsored by the ASAE Committee on Instrumentation and Controls. Contributions on agricultural applications of instruments and controls and related problems are invited, and should be submitted direct to K. H. Norris, Agricultural Research Center, Beltsville, Md.

Increasing the Latitude of a Recording Potentiometer

B. C. Haynes, Jr.
ASSOC. MEMBER ASAE

THE Brown recording potentiometer referred to in this article is of the multipoint type equipped with a timed printing circuit. If the Brown recorder in question is equipped with a number of points which may be evenly divided into the number 12, it is generally equipped with a 12-point rotary switch, which is provided for both copper and constantan switching.

If such an instrument is originally delivered with 2, 3, 4, or 6 points, it may be readily converted to a 12-point recorder simply by rewiring the rotary switch and adding additional copper and constantan connecting wires.

Fig. 1 shows that there is additional space available to mount a second rotary switch. It is possible to utilize existing mounting lugs located on the chassis of the instrument to mount this switch and by mounting it in this position, it is possible to drive it with a 4-to-1 speed reduction from the first shaft of the right-angle drive which actuates the switch furnished as a part of the instrument. The necessary gear train consists of a ½-in-pitch-diameter 48-pitch stud gear mounted directly to the right-angle drive shaft and a 2-in-pitch-diameter 48-pitch stud gear mounted to the shaft of the second rotary switch.

Once the second rotary switch has been mounted, wiring is a simple matter (Fig. 2). The return constantan wire going to the measuring junction from the original rotary switch is removed. Four constantan circuits are led to the second rotary switch, and a return constantan line is run from this switch to the measuring junction.

The author—B. C. HAYNES, JR.—is associate agricultural engineer, farm building and rural housing division (BPISAE), U.S. Department of Agriculture.

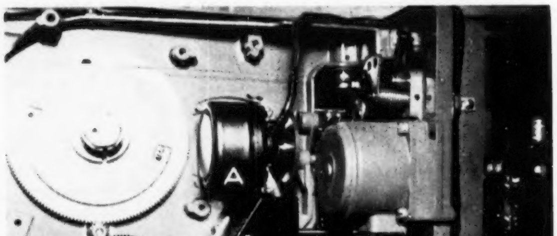


Fig. 1 This picture shows the Brown potentiometer with the second rotary switch indicated at A

With the above-mentioned arrangement and rewiring, it is possible to read four banks of 12 thermocouples, or a total of 48 thermocouples. With this system, it is of course necessary to use a common constantan junction for each bank of 12 thermocouples.

With proper arrangement of mounting and wiring, it is unnecessary to modify the basic instrument in any fashion. If desired, a single-pole, double-throw switch may be incorporated in the wiring in such manner that the instrument may be used either as the 12-point recorder that it was originally designed to be, or as a 4-bank 12-point recorder (totalling 48 thermocouples) by simply moving the double-throw switch to one or the other position.

The second rotary switch used in this installation is a 12-point switch identical to that originally furnished with the instrument. This switch was used in place of a similar 4-point rotary switch only because it had previously been purchased and was on hand. The switch was rewired internally to form the equivalent of a 4-point rotary switch. The internal rewiring of this rotary switch is omitted from the wiring diagram to avoid confusion of lines.

The position of the second rotary switch when the chart drive is started or stopped will indicate the bank of thermocouples first or last printed. Preceding or following banks may then be identified by the time at which they print. Since the instrument pictured prints one point each 30 sec, it will require 6 min to print one bank of points or 24 min to print all 48 points.

One other method which might be used to distinguish between banks would be to maintain a key thermocouple in each bank at a known temperature.

This method of modification can also be applied to a 16-point Brown recorder of the type described.

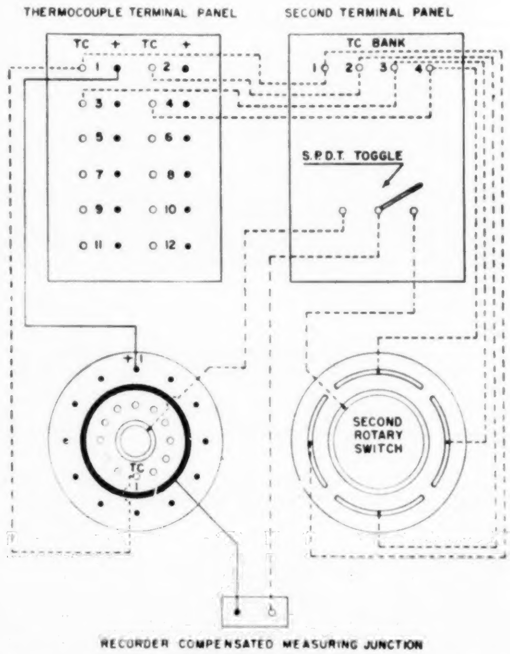


Fig. 2 Wiring diagram with the second rotary switch added to the potentiometer

NEWS SECTION

ASAE Winter Meeting Program

FOR the first time in a number of years the ASAE Winter Meeting is scheduled for the second week in December. As was the case last year, the meeting will be held at the Edgewater Beach Hotel, on Chicago's north shore, where the meeting room layout proved convenient for those who mastered the art of navigating the corridors.

FERTILIZER APPLICATION PROGRAM

One special feature of the meeting will be a fertilizer application program sponsored jointly by the Power and Machinery Division and the National Joint Committee on Fertilizer Application. It is to be held Monday, December 7, with Geo. B. Nutt, of Clemson Agricultural College, vice-chairman of the National Joint Committee, presiding over the forenoon session, and Roy Bainer, University of California, vice-chairman of the Power and Machinery Division, ASAE, presiding during the afternoon.

The forenoon session will open with a review of the history and objectives of the National Joint Committee on Fertilizer Application, by S. D. Gray, general chairman of the Joint Committee. This is to be followed by discourses on new horizons in fertilizer application, by Firman E. Bear, Rutgers University; new developments in fertilizer materials, by Edwin C. Kapusta, National Fertilizer Association; new developments in fertilizer machinery, by C. A. Guelle, International Harvester Co., and fertilizer application in practice, by A. C. Thompson, owner, Thompson's Farms.

A panel discussion on placing fertilizer for efficient production, in the afternoon will have Kirk Fox, editor of *Successful Farming*, as moderator, and the following subjects and speakers: Corn, by G. A. Cumings, U.S. Department of Agriculture; cotton, by J. E. Adams, A & M College of Texas; sod crops, by H. A. Woodle, Clemson Agricultural College; small grains, Floyd W. Smith, Kansas State College, and vegetable crops, by A. C. Thompson, Thompson's Farms.

Following this discussion Mr. Fox will close the fertilizer program with an interpretive summary.

AGRICULTURAL PROCESSING

Another special feature of the meeting will be a one-day program on agricultural processing. It is scheduled for Tuesday, December 8, and is sponsored by the ASAE Committee on Agricultural Processing. While it is not strictly a joint session of the Farm Structures and Rural Electric Divisions, they will avoid holding concurrent sessions during the period, as many of their members are actively interested in various phases of agricultural processing. Carl W. Hall, Michigan State College, chairman of the Committee on Agricultural Processing, will preside.

Introductory discourses will consist of a description of the processing area, by S. M. Henderson, University of California, and processing in Georgia, by Harold D. White, University of Georgia. These will be followed by more specific treatment of each of several aspects of the subject, including agricultural engineering phases of work simplification, by Paul R. Hoff, Cornell University; development of a corn cob processing machine, by R. R. Yoerger and D. C. Bichel, Iowa State College; special handling procedures, by J. H. Levin, Michigan State College; the canning industry as an employer of agricultural engineers, by C. L. Martin, Jr., Green Giant Co.; pasteurization and sterilization, by Irving J. Pflug, University of Massachusetts; some effects of electromagnetic energy and accelerated electrons on certain insects which infest wheat, flour, and beans, by V. H. Baker, Virginia Polytechnic Institute, and use of colored lights for grading, by Blaine F. Parker, Michigan State College.

MOISTURE MEASUREMENT PROGRAM

A joint session of the Rural Electric and Farm Structures Divisions will feature a program on moisture measurement, sponsored by the Committee on Instrumentation and Controls. It is to open with a report of the Committee on Animal Shelter Ventilation, by H. N. Stapleton, University of Massachusetts. Moisture measurement for forage is to be discussed by Mark E. Singley, Rutgers University. Lawrence Zeleny, grain branch, U. S. Department of Agriculture, will speak on standardization of methods for grain moisture measurement. A commercial viewpoint will be represented by W. R. Fetzer, Clinton Food Co., speaking on moisture measurement in industrial operations.

POWER AND MACHINERY PROGRAM

Following its participation in the Fertilizer Application Program on Monday, December 7, the Power and Machinery Division will open its regular program Tuesday, December 8.

The forenoon session will open with the presiding officer, G. M. Eveleth, J. I. Case Co., chairman of the Power and Machinery Division, introducing W. H. Worthington, John Deere Waterloo Tractor Works, who will speak on contemporary British and European farm tractors. Following the discussion and an intermission the group will next hear a report on practical experiences with alcohol-water injection in trucks and farm tractors, by Richard Wiebe, Northern Regional Research Laboratory, U. S. Department of Agriculture.

Design will be approached from two viewpoints at the afternoon session. With R. L. Worrell, Allis-Chalmers Mfg. Co., junior past-chairman of the Division, presiding, the first paper will be on rationalizing analysis in design, by Coby Lorenzen, Jr., California Agricultural Experiment Station. The second speaker will be Paul C. Johnson, editor, *The Prairie Farmer*, who is to talk on what farmers want in farm tractors and implements.

Following an intermission, D. C. Heitshu, chairman of the Steering Committee of the Power and Machinery Division, will preside over an open meeting of the Committee.

Roy Bainer, University of California, vice-chairman of the Division, will preside at the forenoon session on December 9, which will give further attention to design. The first paper is on recent developments in the design of row-crop thinners, by Geo. W. French, U. S. Department of Agriculture, and is to be followed by one on the design and development of a high-speed mower, by Lee Elfes, Harry Ferguson, Inc.

In the second half of the forenoon session E. L. Hunter, agricultural engineer, Wm. Gehring Farms, is to discuss some phases of mechanization of potato harvesting. This will be followed by a report on measuring the resistance of potatoes to bruising, by Richard L. Witz, North Dakota Agricultural Experiment Station.

Pitfalls in the use of mechanics with farm tractors and implements, by A. W. Clyde, Pennsylvania State College, is the first of two major items on the afternoon program of December 9. The second and concluding discussion will be on the possibilities of contour molding for farm machines and tractors, by Garnet P. Phillips, International Harvester Co. George B. Eveleth will preside at this session.

SOIL AND WATER PROGRAM

A three-day program has been planned by the ASAE Soil and Water Division to more adequately cover reports due on problems and progress in various phases of its field.

It will open on Monday forenoon, December 7, with a session on watershed studies. T. W. Edminster is to preside and the first paper is expected to be on the prediction of flood stages on the Mississippi River by model studies, to be presented by a representative of the Vicksburg Station of the Corps of Engineers, U. S. Army. Next on the tentative program is a report on hydrologic similitude studies on agricultural watersheds, by an agricultural engineer in that work.

Representatives of the St. Anthony Falls Laboratory of the University of Minnesota have been invited to present a paper on the hydraulic design features of drainage and flood-control structures.

Planning engineering structures for watershed projects and the new watershed program are also tentatively subjects scheduled for presentation at this session.

Soil and water relationships is the general topic for the Monday afternoon session, with A. J. Wojta, chairman of the Soil and Water Division, presiding. Phases of the subject to be developed include water movement in soils, by M. B. Russell, University of Illinois; rapid methods of determining soil moisture, by J. E. Garton, Oklahoma A & M College; in situ measurement of soil bulk density by gamma ray absorption technique, by J. A. Vomocil, New Jersey Agri-

(News continued on page 716)

ASAE Meetings Calendar

October 15 and 16 — GEORGIA SECTION, Dinkler-Plaza Hotel, Atlanta, Ga.

October 24—MICHIGAN SECTION, Detroit.

November 20 — OKLAHOMA SECTION, Student Union Building, Oklahoma A. & M. College, Stillwater

December 7-9 — WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

February 1-3—SOUTHEAST and SOUTHWEST SECTIONS, Baker Hotel, Dallas, Tex.

April 2 and 3 — ROCKY MOUNTAIN SECTION, Colorado A. and M. College, Fort Collins.

June 20-23—47TH ANNUAL MEETING, University of Minnesota, Minneapolis.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

NEWS SECTION

(Continued from page 714)

cultural Experiment Station, and drainage in the southeastern tideland area, by John P. Thornton, (BPISAE), U. S. Department of Agriculture.

Drainage engineering will be the theme of the Tuesday forenoon session. John G. Sutton, Soil Conservation Service, is to preside. Two papers planned for this period are (1) the determination by four methods of water tables in relation to tile drains, by F. Robert Hore, Ontario Agricultural College, and (2) new research techniques for determining tile depth and spacing, by Lee D. Dumm, U.S. Bureau of Reclamation. Following these the Subcommittee on Depth and Spacing of Tile Drains is sponsoring a round table on tile drainage, with R. K. Frevert, Iowa State College, as discussion leader.

An irrigation session Tuesday afternoon, December 8, will feature common interests in the water requirements of crops. Wayne D. Criddle, U. S. Soil Conservation Service, will preside. Contributions scheduled include one on the heat budget as it relates to water requirements of crops, by V. E. Soumi, University of Wisconsin; evapotranspiration studies, by D. B. Krimgold, Johns Hopkins University; a method of estimating total readily available moisture, by Dale R. Shockley, U. S. Soil Conservation Service, to be discussed by L. L. Harrold, also of the Soil Conservation Service, and a report of the ASAE Subcommittee on Sprinkler Irrigation, by E. H. Kidder, Michigan State College.

Wednesday forenoon, December 9, has been set aside for meetings of various committees of the Division.

The subject of erosion control practices is to be emphasized at the closing session Wednesday afternoon, with John R. Carreker, Soil Conservation Service, presiding. H. B. Atkinson, Soil Conservation Service, and A. J. Wojta, University of Wisconsin, are to open with a discourse on terrace destruction by tillage. A round table on progress in mulch tillage is to follow, with scheduled contributions on the effect on soil erosion, crop yields, and machinery requirements, by W. F. Crain and Helmut Kohnke, Purdue University, and the effects on soil climate, soil fertility, and microbiological activities, by F. W. Schaller, U. S. Department of Agriculture, and D. D. Evans, Oregon State College.

RURAL ELECTRIC PROGRAM

In addition to participating in the special session on agricultural processing and moisture measurement, the Rural Electric Division will present three half-day programs.

E. T. Swink, Virginia Polytechnic Institute, chairman of the division, will preside at the session on Monday forenoon, December 7, which will include the following program numbers: (1) why ground? by O. K. Coleman, Duncan Electric Mfg. Co.; (2) phase converters for rural electric distribution systems, by Wm. G. Bostwick, Motor-X Products Co.; (3) experiences and field records with bulk milk cooling tanks, by C. N. Turner, Cornell University, and (4) progress report on a solar electrically heated greenhouse study, by M. O. Whithed, Atlantic City Electric Co.

Following are the subjects and speakers for the afternoon program: recent developments in and the performance of integral horsepower single-phase motors, by J. B. Steere, C. A. McDade Co.; grain and seed drying with unheated air, by J. W. Simons, University of Georgia; operating characteristics of electric steam accumulators for dairies, by J. M. Stanley, U. S. Department of agriculture, and a power-operated dairy barn sweeper, by Donald W. Richter, Cornell University. W. J. Ridout, Jr., editor, *Electricity-on-the-Farm* magazine, vice-chairman of the Division, will preside at this session.

In the third session, Chairman E. T. Swink will introduce the following speakers and subjects: Marvin Nabben, Northern States Power Co., on development and performance of a conveyor and distributor for chopped hay; Elwood F. Olver, Pennsylvania State College, on automatic dairy feeding; Dawson G. Womeldorff, Public Service Co. of Northern Illinois, on new methods and equipment for feeding livestock, and L. S. Singley, West Penn Power Co., new designs and applications of equipment for processing feed on the farm.

FARM STRUCTURES PROGRAM

A farm housing session is tentatively scheduled for the Monday forenoon (December 7), opening of the farm structures program. N. H. Curry, Iowa State College, chairman of the Farm Structures Division, is to preside. Subjects to be covered include the use of the new flexi-plan in farm house design, by M. R. Hodgell, farm housing technical committee, North Central Region; new materials for home construction, by Jack Parshall, editor, *Building Supply News*; new techniques in home construction, by Rudy Jones, Small Homes Council, University of Illinois, and prefabricated houses, by Milton Male, United States Steel Corp.

On Monday afternoon the farm housing theme will be shifted to farm house facilities. C. H. Jefferson, Reynolds Farm Institute, vice-chairman of the Division, will preside. Subjects to receive attention are developments in home heating, by W. S. Harris, mechanical engineering department, University of Illinois; room arrangement and storage facilities for the farm home, by Olevia C. Meyer, Michigan State College, and the Cornell farm kitchen, by Glenn Beyer, Cornell University. In conclusion Keith H. Hinchcliff, University of Illinois, will present a summary of both housing sessions.

Following its participation in the Agricultural Processing program on Tuesday, December 8, the Division will reconvene Wednesday morning for a session on feeds and feeding. What agricultural engineers should know about feeds will be the general subject for each of three papers. One on feeds for dairy cattle will be presented by R. E. Hodgson, U. S. Department of Agriculture. The second, on feeds for swine, is authored by D. V. Catron, G. C. Ashton, V. C. Speer, and H. L. Chapman, Jr., Iowa State College. Speaking on feeds for beef cattle will be Marvel Baker, associate dean of agriculture, University of Nebraska.

(News continued on page 718)

A group of fifty members and guests of the Washington (D.C.) Section of the American Society of Agricultural Engineers, on August 20, visited Seabrook Farms at Bridgeton, N. J., the world's largest producer-processor of frozen fruits and vegetables. The group was welcomed by Belford Seabrook and given a conducted tour of the facilities and current operations, including the soils testing laboratories; vegetable preparation, packaging, freezing, and storage rooms, and vegetable harvesting. The Company also provided noon luncheon for the group


DURABLE

NEWS SECTION

(Continued from page 716)

Downing New Chairman North Atlantic Section

C. G. E. DOWNING, head, agricultural engineering department, Ontario Agricultural College, Guelph, was elected the new chairman of the North Atlantic Section of the American Society of Agricultural Engineers at its yearly meeting last month, held on the campus of the Long Island Agricultural and Technical Institute at Farmingdale, N. Y. He succeeds W. J. Ridout, Jr., editor, *Electricity on the Farm* magazine.

C. G. E. Downing (left) takes over as new chairman of ASAE North Atlantic Section from W. J. Ridout, Jr. (right)

The new vice-chairman of the Section, elected at the same meeting, is W. D. Hemker, agricultural engineer, industry sales department, Westinghouse Electric Corp. The new secretary of the Section is C. N. Turner, professor of agricultural engineering, Cornell University, and project leader of the New York Farm Electrification Council.

Pennsylvania Section Elects Walton

HAROLD V. WALTON, associate professor of agricultural engineering, Pennsylvania State College, was elected the new chairman of the Pennsylvania Section of the American Society of Argicultural Engineers at a special business meeting of the Section held in conjunction with the meeting last month of the North Atlantic Section of the Society at Farmingdale, Long Island, N. Y. He succeeds Albert M. Best, engineer, New Holland Machine Div., The Sperry Corp.

At this meeting the Section also elected Luther S. Singley, agricultural engineer, West Penn Power Co., as the new vice-chairman of the Section, and James B. Kistler, assistant superintendent of college farms, Pennsylvania State College, was re-elected as secretary of the Section.

Martin Heads Pacific Northwest Section

JAMES W. MARTIN, head, agricultural engineering department, University of Idaho, was elected chairman of the Pacific Northwest Section of the American Society of Agricultural Engineers for the 1953-54 year at the regular yearly meeting of the Section held on the campus of the University of British Columbia at Vancouver in September. He succeeds Jesse E. Harmond, U. S. Department of Agriculture, stationed at Corvallis, Ore.

At the same meeting four new vice-chairmen of the Section were elected as follows: Francis A. Farrow, designer, MacMillan and Bloedel, Ltd., Vancouver; Lawrence R. Swarner, engineer, Bureau of Reclamation, U. S. Department of the Interior; Ben W. Faber, owner, Ben Faber Electric, Hillsboro, Ore.; and Lowell Kennedy, a member of the student branch of ASAE at the State College of Washington.

New secretary of the Section is Perry R. Bakes, farm representative, Washington Water Power Co., Pullman, Wash. He succeeds Robert S. Tait, manager of the Rainbird Sprinkler Mfg. Co. of Canada, Vancouver.

NEWS OF ASAE MEMBERS

Murrel L. Bailey, on temporary assignment for a three-year period in connection with the USA Point Four Program at the Facultad de Agronomia, Medellin, Columbia, has returned to his former position as assistant professor of agricultural engineering, Michigan State College, East Lansing.

Norman L. Beigh recently resigned as a junior engineer with the Lantz Manufacturing Co., Valparaiso, Ind., to accept a similar position in the product engineering department of the Ford Tractor Division, Ford Motor Co., Birmingham, Mich.

Ben W. Bickham, who has been on active duty with the U.S. Air Force has been released and is now employed by the Noel Company, Bay City, Texas.

William R. Bower has resigned as electrification advisor of the Northwest Rural Electric Cooperative Assn., Cambridge Springs, Pa., to accept an engineering assignment in quality control work with the United Cooperatives, Inc., Alliance, Ohio.

Henry C. Bradford, Jr., formerly a field engineer for the Portland Cement Assn., is now engaged in general farming at West Ridge, Ark., and in addition is engaged in the professional practice of agricultural engineering specializing in farm structures.

Ross D. Brazee, who has been serving as graduate research assistant in agricultural engineering at Michigan State College, recently began duty with the armed services.

James R. Chandler has resigned as a territory supervisor of the J. I. Case Co., to accept employment as an industrial engineer with The Maytag Co., Newton, Iowa.

Earle F. Cox, until recently employed by the Harris Mfg. Co., Stockton, Calif., recently resigned to accept employment as a consultant in the fields of engineering and manufacturing for Booz, Allen, and Hamilton, 285 Madison Ave., New York 17, N.Y.

William E. Davidson, until recently test engineer, design section, refrigeration division, General Electric Co. at Erie, Pa., has been transferred to the Company's small appliance division at Cleveland where he is employed as an engineer in the advanced engineering design and development section of the Company's vacuum cleaner works.

Joseph L. Dirnberger, formerly a junior civil engineer for the Tela Railroad Co., a division of United Fruit Co., in Honduras, is now associated with Portable Aluminum Irrigation Co. His address is 1033 Crescent Drive, Vista, Calif.

William C. Fairbank recently resigned as assistant agricultural engineer, Pineapple Research Institute of Hawaii, to take a position as sales engineer with the canning machinery division of the Food Machinery and Chemical Corp., San Jose, Calif.

A. C. Falconer was recently appointed to the position of engineer's assistant with the Ontario Department of Public Works and is now in charge of all the agricultural drainage in the northern part of the Province of Ontario. His address is Court House, North Bay, Ontario.

Victor C. Fuhrwerk has resigned as design engineer of Starline, Inc., to take a position with the International Harvester Company's experimental farm at Hinsdale, Ill.

William C. George, in charge of agricultural engineering work at Arkansas State College, recently resigned to accept appointment on the agricultural engineering teaching staff at the University of Arkansas, Fayetteville.

Willard D. Hansen, formerly design engineer, Hurst Industries, Inc., Santa Clara, Calif., recently resigned to accept appointment as engineer for the Loma Prieta Soil Conservation District, as a member of the U.S. Soil Conservation Service staff at Morgan Hill, Calif.

Charles N. Hinkle, until recently instructor in agricultural engineering at Michigan State College, is now employed as a market specialist in the marketing service department of the Armco Steel Corp., Middletown, Ohio.

E. Clem Jensen, formerly a sales engineer for Mechanics Universal Joint Div., Borg-Warner Corp., is now regional sales manager of the Bower Roller Bearing Co., Detroit, Mich.

Morel Leonard has resigned as manager of the wood products division, United Cooperatives, Inc., to become associated with Southwest Unit Structures, Inc., Magnolia, Arkansas.

John J. Lliteras recently resigned as field engineer for Master Plumbers, to accept employment in the capacity of sales engineer for the Rain Chief Irrigation Co., Grand Island, Nebr.

Mansel M. Mayeux, until recently associate extension agricultural engineer, Louisiana State University, is now employed as chief inspector of the Anhydrous Ammonia Commission, Louisiana Department of Agriculture and Immigration, Baton Rouge.

M. J. Morgan recently accepted appointment as assistant professor on the agricultural engineering staff of the State College of Washington, Pullman. He was previously employed as a junior project engineer of the New Idea Division, Avco Corporation, Coldwater, Ohio.

August D. Pistilli has resigned as resident engineer for the KTAM Engineering Co. to accept the position of superintendent for the American Dredging Co., Philadelphia.

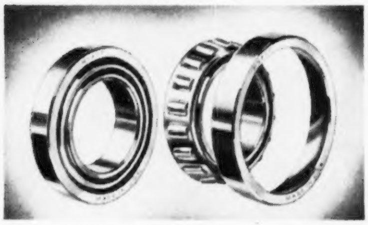
Everett M. Sandahl has resigned as a member of the agricultural engineering staff of Iowa State College to accept a position as designer, product engineering department, McCormick Works, International Harvester Co., Chicago.

Claris W. Williams has been promoted from salesman to parts manager of the Grimes Tractor and Implement Co., Montgomery, Ala.

NEW PRODUCTS CATALOGS

Self-Aligning "Barrel Bearing"

Hyatt Bearing Division, General Motors Corp., Harrison, N. J., has announced that, for the first time, its self-aligning "barrel bearing" is available in volume quantities for general industrial applications. The name of the bearing comes from the barrel shape of the rollers;



it has been developed and perfected by Hyatt engineers over a number of years. Accurately ground barrel-shaped rollers, combined with precise race contours, provide maximum load-carrying capacity throughout a wide range of operating conditions. These angular contact bearings are designed to sustain radial, thrust, or combination loads and are freely self-aligning. Conditions of shaft misalignment do not interfere with their operation.

Four New Farm Tractor Models

John Deere announces the introduction of four new tractor models, which are now in production at its tractor plants at Waterloo and Dubuque, Iowa.

For the first time Deere offers LP (liquid petroleum) gas models. These are the John Deere 60 and 70 tractors, especially designed to burn LP gas. These tractors will develop essentially the same horsepower as the gasoline-burning models. Among the engineering modifications made for burning LP gas are higher compression ratio, cold manifold, special LP-gas carburetor, and a new-type ignition with a resistor bypass.

The new John Deere 40 crawler tractor has a 4-roller track and replaces the 3-roller model. The 5-roller assembly is available as optional equipment. The track rollers are now equipped with steelbacked bronze bushings and face-type seals, and require lubrication only once every 120 hours of use. Both models are powered with the 40 series engine.

Two other new John Deere tractors are the new 3-4-plow 60 standard and 60 orchard models which replace the AR and AO models, respectively. The new models include many engineering improvements and design changes.

Complete information on these new models will be supplied on request to John Deere, Moline, Ill.

Spray Guns Bulletin

Spraying Systems Co., 3226 Randolph St., Bellwood, Ill., has issued a new bulletin describing and illustrating its new series of GunJet spray guns for orchard and livestock spraying and related uses, which are identified as series No. 12 and No. 14. Both are offered as standard spray gun units or in a variety of valve and handle assemblies. The basic difference between the series is that the No. 12 is built with garden hose connection and the No. 14 with 3/4-in female pipe connection. Both are heavy-duty guns for use with pressures from 30 to 800 psi. Bulletin No. 69 describing these GunJet spray guns will be sent on request to the company.

Improved Sprocket Chains

Chain Belt Co., Dept. P.R., Milwaukee 1, Wis., announces an improved line of drive and conveyor sprocket chains, designated as the R, RX, and RR series which will replace and supplement a group of the most standard and popular sizes of the Rex Chabelco line of steel chains. The area of improvement includes controlled material selection and heat-treatment for greater wear resistance and strength, closer planned tolerances of press fits for longer life and smooth operation, better finishes, easier assembly and disassembly, and at no increase, in fact at lower prices on some sizes. The new series of chains will operate on standard sprockets. Being a selected group of the most popular and standard Chabelco chains, they are available at all Chain Belt Co. warehouses and distributors.

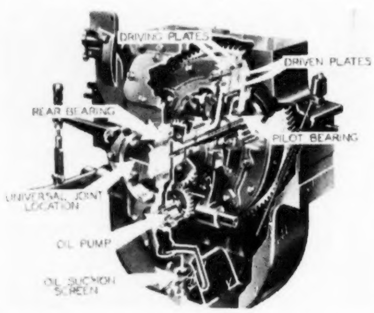
Heavy-Duty Spark Plug

The Electric Auto-Lite Co., Spark Plug Div., Toledo, Ohio, announces a new type spark plug expressly designed for heavy-duty use in farm equipment. Known as the "Transport" spark plug, it is especially designed with a wider heat range to meet the varied operating conditions of most tractors, combines and other gas-powered farm equipment. These spark plugs also have aluminum oxide insulators to withstand heat, as well as heavy-duty electrodes to reduce the required voltage to fire the plugs. Their cost is the same as for standard spark plugs.

Oil-Type Flywheel Clutch for Tractor-Type Machines

Caterpillar Tractor Co., Peoria, Ill., has introduced an oil-type flywheel clutch on three of its track-type machines, the Cat D8 and D6 tractors and the Caterpillar No. 6 shovel. An important operating feature of this new clutch is that it will operate two to four times longer than an equivalent dry clutch before major adjustment or overhaul is necessary. It is expected that under ordinary operating conditions the overhaul period of this clutch will coincide with the normal overhaul of the engine.

Since friction material operating in oil has a much lower coefficient of friction, the engaging force (squeeze on the pressure plate) of an oil clutch must be higher than an equivalent dry clutch. On this account, in the development of the new Caterpillar oil-type clutch an engaging mechanism is provided which has



a high mechanical advantage and since the heavily loaded internal parts have been especially hardened, the pull required by the operator on the clutch handle has been reduced.

An innovation being introduced with this clutch is a universal joint which eliminates the need for close alignment between the clutch and transmission, thus causing lower maintenance problems in the clutch and transmission bearings and shafts.

This oil clutch represents more than 11 years of research and development by Caterpillar.

Snap Coupler Tractor Hitch

Allis-Chalmers Mfg. Co., Tractor Division, Milwaukee, Wis., announce a new "snap" coupler system for instant hitching of rear mounted WD implements to WD tractors now in use as well as for the WD 45 tractor and its line of implements. This coupler is an automatic coupling device set in a wide funnel located at the tractor's single-hitch point. When a tractor is backed up to the implement, the funnel guides the tongue of the mounted implement into the coupler where it automatically snaps into working position. The operator then snaps the two implement lift links to the tractor lift arm latches. With this hitch it is not necessary to

make a pin-point connection with the tongue of the mounted implement; the operator can back into it at an angle because the 8-inch funnel guides the tongue directly into the coupler. Exact positioning of the tractor is unnecessary and no bolts, pins or cotter keys are used.

Taper-Lock Roller Chain Sprockets

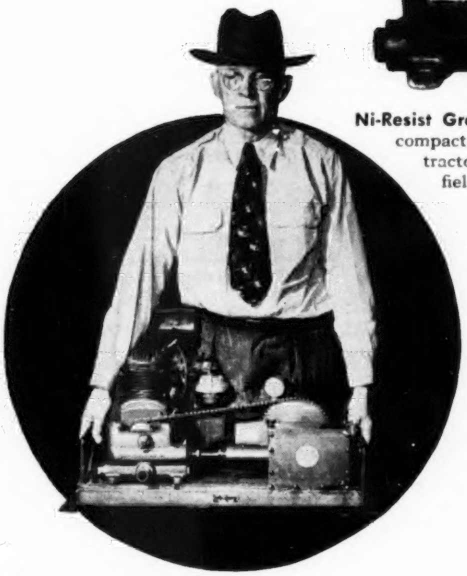
Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., will mail on request to interested readers a copy of its new 16-page, pocket-size catalog (B55-53) listening prices and specifications for Morse taperlock stock roller chain sprockets. The tables in this catalog list horsepower ratings, taper-lock bushing and sprocket specifications and prices, and roller chain and part specifications and prices for 1/2, 5/8, 3/4, 1 and 1 1/4-in-pitch chain. Installation and removal procedures for taper-lock sprockets are listed in the catalog as well as horsepower selection charts, drive selection procedures and service factor tables. The catalog also includes prices for Morse packaged roller chains which can be had in individual boxes of 5, 10, 50 and 100-ft lengths.

Welding Nickel Alloy Steels

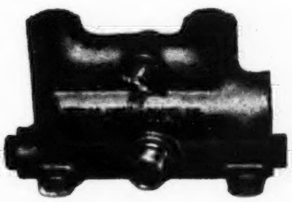
The International Nickel Co., 67 Wall St., New York 5, N. Y., announces publication of Bulletin A-93, "The Welding of Nickel Alloy Steels," with tables, graphs and illustrations. It presents a study of the various welding techniques, including some of the newer inert gas processes, electrodes, preheat-treatments and post-heat treatments. Typical results that can be expected are given for the low-alloy high-strength steels, low-carbon and medium-carbon engineering alloy steels, and special steels. Copies of the bulletin will be sent on request to the company.

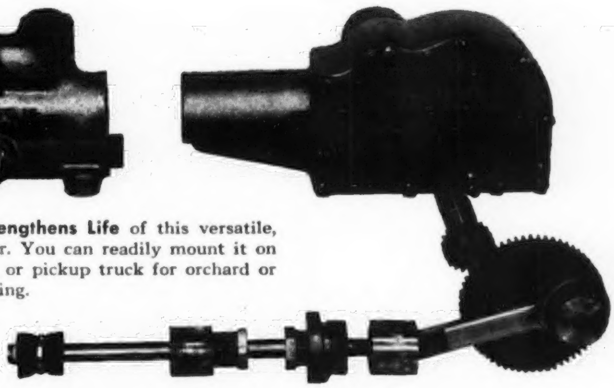
Fertilizer Application Guide

Ezee Flow Division, Avco Mfg. Corp., 10 S. LaSalle St., Chicago 3, Ill., will send on request to interested readers its booklet, entitled "Fertilizer Application Guide for Major Field Crops." This is a 40-page booklet which supplies pertinent information on methods of fertilizer application for major field crops. The booklet also includes much helpful information on the operation, adjustment, etc., of Ezee Flow equipment.



Ni-Resist Greatly Lengthens Life of this versatile, compact sprayer. You can readily mount it on tractor, jeep or pickup truck for orchard or field spraying.





This pump spray body is made of Ni-Resist to resist corrosion and erosion. To avoid breakage the connecting rod, the large gear and small integral shaft shown above are cast of tough, strong Ductile Iron. Both the Ni-Resist and Ductile Iron parts are produced by TEXALOY FOUNDRY COMPANY of San Antonio, Texas.

100 lb. power sprayer works better, longer . . . by utilizing NI-RESIST

No other cast metal provides such a unique combination of useful engineering properties

Operated by a two horsepower motor, this versatile sprayer can raise 6 to 8 gallons of liquid per minute in a stream 25 feet high at 200-250 lb. pressure.

Primarily designed for disinfecting live stock and barns, the Lone Star Power Sprayer can spray trees, crops, soil, wipe out weeds, or even help wash the car and put out incipient fires.

The entire pump block is cast in Ni-Resist® a high nickel alloy iron . . . for two significant advantages: to defeat corrosive attacks by organic acids, chlorides and other compounds in insecticides and fungicides . . . and to curb erosion and abrasion from the solid particles in slurries traveling at high speeds.

Adopted because of its demonstrated superiority over bronze and other materials in similar applications, Ni-Resist has proved highly satisfactory to the TEXAS PEAR BURNER COMPANY of Pearsall, Texas, makers and marketers of this sprayer.

Several types of Ni-Resist are available to meet a variety of demands. Get full information . . . mail coupon now.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

The International Nickel Company, Inc. A-E 10-53
Dept. 20, 67 Wall Street, New York 5, N. Y.

Please send me booklets entitled, "Engineering Properties and Applications of Ni-Resist," and, "Buyers' Guide for Ni-Resist Castings."

Name.................................... Title....................

Company ....

Address ....

City.................................... State....................

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

BABINSKI, JOHN D.—Farmer, 1112 S. Oak St., Grand Forks, N. D.

BALLS, IVAN J.—Engineer, Plant Protection Ltd., Research Station, Fernhurst, Nr. Haslemere, Surrey, England. (Mail) 11 Homelands Copse

BERKY, RICHARD K.—Engineering trainee, New Holland Machine Co. (Mail) Box 519, RR 5, Lancaster, Pa.

BOOKER, WALTER W.—Student engineer, John Deere Ottumwa Works, Ottumwa, Iowa. (Mail) 316 Carter Ave.

BUSSE, G. E.—Agricultural specialist, Saskatchewan Power Corp., 1739 Cornwall St., Regina, Sask., Canada

DEVRIES, LOUIS S.—Agricultural engineer, Oak's Irrigation Equipment Co. (Mail) RR 2, Box 134, Edinburg, Tex.

FRENCH, ROBERT F.—Assistant product development engineer, International Harvester Co., Moline, Ill. (Mail) 832 16th Ave.

GARCIA, JOAQUIN L.—President, Tractores Centro S. A., PO Box 86, Cienfuegos, Cuba

GEISER, MELVIN E.—Instructor, Pennsylvania State College, State College, Pa. (Mail) 1123 Oneida St.

GUSTAFSON, J. CHARLES—Ens., U.S. Navy. (Mail) U.S.S. Wheatear (AM-390), Fleet P.O., New York, N. Y.

HANRAHAN, FRANK J. — Executive vice-president, American Institute of Timber Construction, Suite 100, 1757 K St., N.W., Washington 6, D.C.

HORNEY, DAVID C.—Student engineer, John Deere Waterloo Tractor Works, Waterloo, Iowa. (Mail) 226 Leland Ave.

KAVENEY, GARY S.—Farmer, Box 282, Colusa, Calif.

McCLUNG, LESTER M. — Field representative, The Gulf Fertilizer Co., PO Box 295, Safety Harbor, Fla.

OERMAN, OREY W. — Product engineer, John Deere Plow Works, Moline, Ill. (Mail) 857 19th St.

SCHLUTER, F. E.—Chairman of board (advisory), Thermoid Co., Whitehead Road, Trenton 6, N. J.

SLAUSON, LAWRENCE T.—President, Alsco, Inc., P.O. Box 485, Sta. A, Richmond, California

STEVENSON, WILLIAM L.—Junior engineer, J. I. Case Co., Rock Island, Ill.

TODD, MERYL L. — Consulting engineer, Todd, Hedeen & Assoc., 80 Commercial St., Waterloo, Iowa

TRAUTMANN, CARL O.—Experimental test engineer, Allis-Chalmers Mfg. Co., West Allis, Wis. (Mail) 1549 S. 75th St.

WADLEIGH, RONALD G.—Electrification advisor, San Luis Valley Rural Electric Cooperative, Inc., Box 55, Monte Vista, Colorado

WHITMORE, ROLAND B.—Technical writer, Oliver Corp., Charles City, Iowa. (Mail) 1309 G St.

TRANSFER OF MEMBERSHIP GRADE

FOX, ARTHUR G., JR.—Agricultural engineer, New England Power Service Co., 216 High St., Clinton, Mass. (Associate Member to Member)

GARNER, J. K.—Agricultural machinery and repair shop advisor to the government of Pakistan, Karachi, Pakistan. (Mail) Hotel Metropole. (Associate Member to Member)

RICH, NATHAN H.—Assistant professor of agricultural engineering, University of Maine, Orono, Me. (Associate Member to Member)

YECK, ROBERT G. — Assistant agricultural engineer, (BPISAE), USDA. (Mail) 38 Maplewood Drive, Columbia, Mo. (Associate Member to Member)

SURPLUS AND SHORTAGE

E. R. Gross, 33 Cleremont Ave., New Brunswick, N. J., offers for sale a complete set of AGRICULTURAL ENGINEERING, 1920-1952, vols. 1-33 (1920-42 bound in red buckram, 1943-52 not bound). Also ASAE Transactions 1910-35 (bound in green buckram). All in excellent condition. Ship by freight f.o.b. New Brunswick. Price $450.

Fred D. VanAken, 1600 Melrose Ave., Knoxville, Tenn., offers for sale complete volumes (unbound) of AGRICULTURAL ENGINEERING for 1950, 1951, and 1952. Price, $3.60 per volume postpaid.

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — MARCH — 0-99-509. MAY — O-140-516. JUNE — O-206-521, 208-522, 147-524. JULY — O-254-526, 255-527, 270-528. SEPTEMBER — O-301-530, 330-531, 331-532.

POSITIONS WANTED — FEBRUARY — W-21-5, 19-6, 26-7. MARCH — W-29-9, 56-10, 79-15, 85-16, 68-17. APRIL — W-64-19. MAY — W-120-23, 163-27, 151-28, 169-29, 193-31, 196-32. JUNE — W-204-34, 205-35, 200-36, 203-37, 220-40. JULY — W-231-41, 260-42, 266-43. AUGUST — W-269-44, 248-45, 272-46, 234-47, 278-49, 292-50, 281-51, 294-52. SEPTEMBER — W-306-53, 321-54, 324-55, 339-56.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER, instructor, to teach service courses in power and machinery or irrigation and surveying, or both, in a land-grant college in the Southwest. BS deg in agricultural engineering, or equivalent. Farm background. Good health and scholastic record. Initiative and dependability. Housing near college very reasonable. Living costs relatively low. Opening effective now. Salary $325-375 per mo, depending on qualifications. O-346-533

AGRICULTURAL ENGINEERS (2) and DEVELOPMENT ENGINEERS (2) for field study, design, development and sales promotion on agricultural and industrial equipment items with eastern manufacturer of rubber products. BS deg in agricultural or mechanical engineering. Dairy farm background and practical experience in handling farm equipment. Usual personal qualifications for engineering in industry. Age 25-35. Excellent opportunity for advancement. Limited travel. Bonus system, sick benefits, and retirement plan. Salary $350 to 600 per mo, depending on qualifications. O-348-534

AGRICULTURAL ENGINEER, instructor, to teach professional and service courses in farm shop, structures, and machinery in a state college in the Southwest. BS deg or higher in agricultural engineering or equivalent. Farm background. Summer teaching included. About 8 weeks' vacation. Opening effective now. Salary $4764. O-352-535

AGRICULTURAL or CIVIL ENGINEER (GS-7) for design, layout, and supervision of construction of small dams, terraces, diversions, water spreaders, irrigation systems, land leveling, etc., in a western state. BS deg in agricultural or civil engineering and one year experience. Able to meet and deal with farmers and ranchers. If applicant has permanent federal Civil Service status, transfer can be effected at present grade and salary. Salary $4,205, with $125 annual increase. O-344-536

SALES ENGINEER to call on water well drillers and others concerned with water supply and use, representing manufacturer of well screens. Work would be largely educational, and require travel over much of the United States. Headquarters in Minneapolis. BS deg in agricultural, civil, and/or hydraulic engineering. Experience in water supply, well drilling, or as a geologist desirable. Pleasing personality and ability to get along with people. Organization is small and not departmentalized, providing maximum opportunity to learn and become valuable in all phases of the business. Age 30-35. Salary open, in line with current rates for comparable training and experience. O-361-537

NEW POSITIONS WANTED

AGRICULTLRAL ENGINEER and economist for extension, teaching, research, sales, writing, or management, in soil and water, product processing, market analysis, economic and sales research, or promotional work, with college, manufacturer, distributor or trade association, any location. Enjoy working with people. Better than average writing ability. BS deg in agricultural engineering, 1941, Virginia Polytechnic Institute. MS deg 1947; Ph D in land economics and marketing expected February 1954, Cornell University. Farm background. Weigh clerk and bookkeeper, livestock market,

(Continued on page 726)

Professional Directory

RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

Personnel Service Bulletin

(Continued from page 724)

one year. Warehouse custodian and bookkeeper, petroleum industry, one year. Local and state supervisor for federal agricultural conservation program three summers. Junior conservationist SCS, one year. Navy commissioned war service 3 yr, including 2 yr as engineering officer. Married. Age 33. No disability. Available Jan. 1. Salary $6000. W-333-57

AGRICULTLRAL ENGINEER for extension, teaching, research, sales, service, or writing in power and machinery or soil and water field with experiment station, federal agency, consultant or farming operation in Pacific Coast area, Mexico, or South America. Will travel. BS deg in agricultural engineering, 1950, Texas A & M College. Agricultural engineer in design, layout, and construction of irrigation and drainage installations, with SCS, 32 mo war enlisted service in Army Air Corps as Link and Celestial Navigation trainer operator, 3 yr. Gunsmith 2 yr. Farm background. Married. Age 37. No disability. Available on two weeks' notice. Salary $400 per mo. W-357-58

AGRICULTURAL ENGINEER for sales, service, or extension and related writing and management in power and machinery field, with industry, any location. Will travel. Enjoy working with other engineers, dealers, and farmers; organization and program development work; public speaking. Interested in opportunity requiring initiative, enthusiasm, and drive. Favor sales engineering as applied to helping farmers organize their mechanization and buildings for efficient operation. Public service extension and research over 2 yr. With tractor and equipment manufacturer in product education and service management over 4 yr. Naval Reserve commissioned war service with Bureau of Ships, over 4 yr. Married. Age 34. No disability. Available on reasonable notice. Salary open. W-359-59

NEW BOOKS

PIPE AND TUBE BENDING, by Paul B. Schubert. Cloth, viii + 183 pages, 6 x 9 inches. Illustrated and indexed. Industrial Press (148 Lafayette St., New York 13, N. Y.). $5.00.

This new reference compares methods and equipment for shop and field production bending, as to capacity, performance, limitations, pipe materials, and pipe service requirements, as an aid to the selection of methods and equipment well suited to the user's particular needs. Chapters cover methods of bending, lengths and minimum radii of bends, the use of fillers and mandrels in bending, compression bending, draw bending, ram and press bending, roll bending, wrinkle-bending, hot bending of large sized pipe and tubing, production pipe bending using wooden forming dies, pipe-and-tube-coiling, and bending operations in the field.

the BADGE of him who BELONGS

DESPITE the *presumption* it sets up, mere membership in the American Society of Agricultural Engineers is no *proof* of a man's high rank in technical talent. It does prove that he has met certain minimum requirements and has earned the esteem of colleagues who sponsored his application for membership.

But the Society emblem is *evidence* that native talent, be it great or small, is enriched by fraternity with the personalities whose minds fuse to form the pattern of progress in the methods and mechanics of agriculture. The wearer of the emblem waits not for the debut of an idea, but is present at its birth and helps to guide its growth.

Be you novice or veteran, your membership in the organized profession adds something to your efficiency, your vision, your influence as an individual engineer. The Society symbol on your lapel is token that you "belong". Wear it.

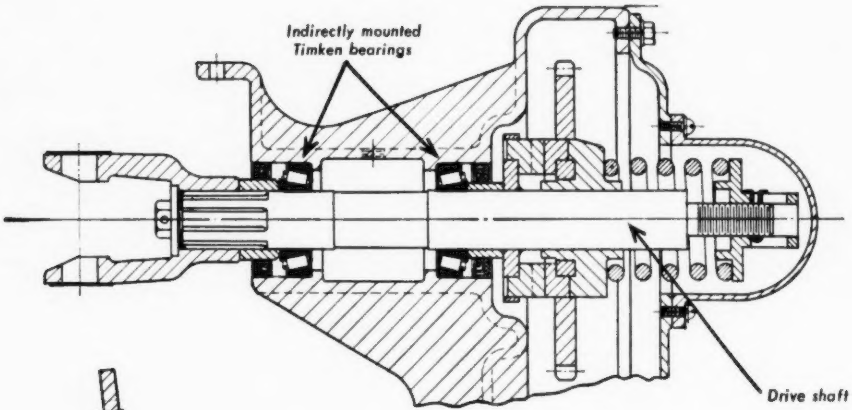
STYLES AND PRICES OF ASAE EMBLEMS

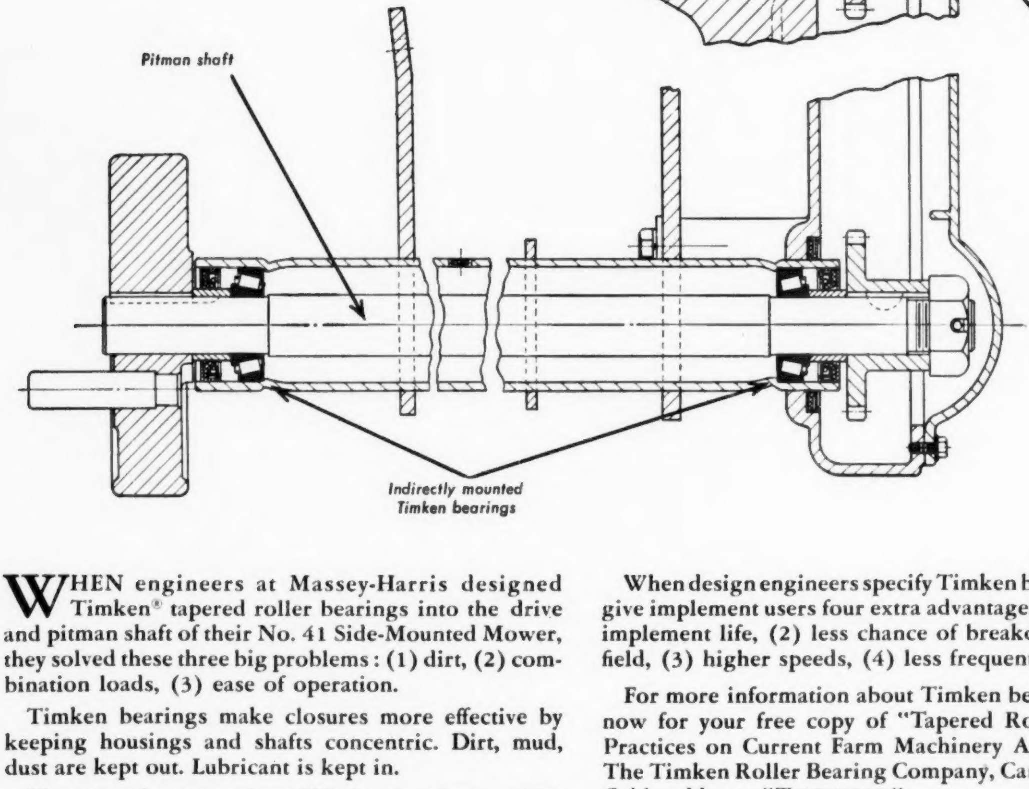
With blue ground for Fellows, Members, and Associate Members — furnished either in pin with safety clasp or lapel button — $3.50 each.

With red ground for Affiliates — furnished only in pin with safety clasp — $3.50 each.

Send orders to ASAE, St. Joseph, Michigan.

Massey-Harris Solves Mower Design Problems by Putting Timken® Bearings on Drive and Pitman Shafts





WHEN engineers at Massey-Harris designed Timken® tapered roller bearings into the drive and pitman shaft of their No. 41 Side-Mounted Mower, they solved these three big problems: (1) dirt, (2) combination loads, (3) ease of operation.

Timken bearings make closures more effective by keeping housings and shafts concentric. Dirt, mud, dust are kept out. Lubricant is kept in.

The tapered construction of Timken bearings enables them to take both radial and thrust loads in any combination. Shafts are held in accurate alignment, minimizing deflection and end-play.

Timken bearings practically eliminate friction because of their true rolling motion and incredibly smooth surface finish. Moving parts rotate more freely. Mower operations are easier, smoother.

When design engineers specify Timken bearings, they give implement users four extra advantages: (1) longer implement life, (2) less chance of breakdowns in the field, (3) higher speeds, (4) less frequent lubrication.

For more information about Timken bearings, write now for your free copy of "Tapered Roller Bearing Practices on Current Farm Machinery Applications". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

The farmer's assurance of better design

TIMKEN Tapered Roller BEARING EQUIPPED

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION